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California Environmental Protection Agency
AIR RESOURCES BOARD

**CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR
~~2009~~ 2011 AND SUBSEQUENT MODEL ZERO-EMISSION VEHICLES, AND ~~2001~~
AND ~~SUBSEQUENT MODEL~~ HYBRID ELECTRIC VEHICLES, IN THE PASSENGER
CAR, LIGHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE CLASSES**

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Note: The proposed amendments to this document are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions compared to the test procedures as presented to the Board on March 27, 2008 as part of the “Rulemaking to Consider Adoption of the 2008 Amendments to the California Zero-Emission Vehicle Regulation.” Proposed fifteen-day changes to this document that were presented to the Board at the March 27, 2008 rulemaking are indicated by double underline to indicate additions and ~~double-strikeout~~ to indicate deletions compared to the test procedures issued with the 45-day notice for the Board hearing. Existing intervening text that is not amended is indicated by “* * * *”.

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NOTE: This document is incorporated by reference in section 1962(h), title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certification of zero-emission vehicles and hybrid electric vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. “California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles” (incorporated by reference in section 1961(d), title 13, CCR);
2. “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles” (incorporated by reference in section 1976(c), title 13, CCR);
3. “California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles” (incorporated by reference in section 1978(b), title 13, CCR);
4. OBID II (section 1968, et seq. title 13, CCR, as applicable);
5. “California Environmental Performance Label Specifications for 2009 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles” (incorporated by reference in 1965, title 13, CCR);
6. Warranty Requirements (sections 2037 and 2038, title 13, CCR);
7. “Specifications for Fill Pipes and Openings of Motor Vehicle Fuel Tanks” (incorporated by reference in section 2235, title 13, CCR);
8. Guidelines for Certification of Federally Certified Light-Duty Motor Vehicles for Sale in California (incorporated by section 1960.5, title 13, CCR); and
9. “California Non-Methane Organic Gas Test Procedures,” (incorporated by reference in section 1961(d), title 13, CCR).

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CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR ~~2009~~ 2011 AND SUBSEQUENT MODEL ZERO-EMISSION VEHICLES, ~~AND 2001~~ AND ~~SUBSEQUENT MODEL~~ HYBRID ELECTRIC VEHICLES, IN THE PASSENGER CAR, LIGHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE CLASSES

A. Applicability

The emission standards and test procedures in this document are applicable to ~~2009~~ 2011 and subsequent model-year zero-emission passenger cars, light-duty trucks and medium-duty vehicles, and ~~2001~~ 2011 and subsequent model-year hybrid electric passenger cars, light-duty trucks and medium-duty vehicles. The general procedures and requirements necessary to certify a vehicle for sale in California are contained in the “California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles” (hereinafter “LDV/MDV TPs”), and apply except as amended herein. A manufacturer may elect to certify a ~~2000~~ 2009 or a 2010 model-year hybrid electric vehicle under these standards and test procedures and the LDV/MDV TPs.

B. Definitions and Terminology

1. Definitions

In addition to the following, these test procedures incorporate by reference the definitions and abbreviations set forth in the Title 40 Code of Federal Regulations (CFR) §86.1803-01, the definitions and abbreviations set forth in the LDV/MDV TPs, and the definitions set forth in section 1900, title 13, ~~California Code of Regulations (CCR)~~.

“Advanced technology PZEV” or “AT PZEV” means any PZEV with an allowance greater than 0.2 before application of the PZEV early introduction phase-in multiplier.

“All-Electric Range” means the total miles driven electrically (with the engine off) before the engine turns on for the first time, after the battery has been fully charged. For a blended off-vehicle charge capable hybrid electric vehicle, the equivalent all-electric range shall be considered the “all-electric range” of the vehicle.

“All-Electric Range Test” means a test sequence used to determine the range of an electric vehicle or of a hybrid electric vehicle without the use of its auxiliary power unit. The All-Electric Range Test cycle consists of the Highway Fuel Economy Schedule and the Urban Dynamometer Driving Schedule (see section E of these test procedures).

“Alternate Continuous Urban Test Schedule” means a repeated series of the following sequence: UDDS, 10 minute key off hot soak, UDDS, and 10-20 minute key off hot soak. This alternate procedure may be substituted for the Continuous Urban Test Schedule when the Continuous Urban Test Schedule cannot be performed.

“Alternate Continuous Highway Test Schedule” means a repeated series of the following sequence: HFEDS, 15 second key on pause, HFEDS, and 10-20 minute key off hot soak. This alternate procedure may be substituted for the Continuous Highway Test Schedule when the Continuous Highway Test Schedule cannot be performed.

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“Auxiliary power unit” means a device that converts consumable fuel energy into mechanical or electrical energy. Some examples of auxiliary power units are internal combustion engines, gas turbines, or fuel cells.

“Battery electric vehicle” or “BEV” means any vehicle that operates solely by use of a battery or battery pack, or that is powered primarily through the use of an electric battery or battery pack but uses a flywheel or capacitor that stores energy produced by the electric motor or through regenerative braking to assist in vehicle operation.

“Battery or Battery pack” means any electrical energy storage device consisting of any number of individual battery modules or cells that is used to propel a battery electric or hybrid electric vehicle. These terms may also generically refer to capacitor and flywheel energy storage devices in the context of hybrid electric vehicles.

“Battery state-of-charge” means the quantity of electrical energy remaining in the battery relative to the maximum rated capacity of the battery expressed in percent.

“Blended off-vehicle charge capable hybrid electric vehicle” means an off-vehicle charge capable hybrid electric vehicle that uses the engine to supplement battery/electric motor power during charge depleting operation.

“Blended operation mode” means an operating mode in which the energy storage state-of-charge decreases, on average, while the vehicle is driven and the engine is used occasionally to support power requests.

“Charge-depleting” means that the battery of a hybrid electric vehicle ultimately fully discharges and impairs vehicle operation as the vehicle continuously operates over a given driving cycle when no off-vehicle charging is performed and the consumable fuel is regularly replenished. Hybrid electric vehicles are required to be classified as either charge-sustaining or charge-depleting over each driving cycle (i.e. UDDS, HFEDS, US06, or SC03).

“Charge-depleting net energy consumption” means the net electrical energy, E_{cd} , measured in watt-hours consumed by vehicle over the charge depleting cycle range, R_{cdc} . E_{cd} can be expressed as AC or DC watt hours, where appropriate.

“Charge-depleting (CD) mode” means an operating mode in which the energy storage state-of-charge (SOC) may fluctuate but, on average, decreases while the vehicle is driven. Hybrid electric vehicles are required to be classified as either charge-sustaining or charge-depleting over each driving cycle (i.e. UDDS, HFEDS, US06, or SC03).

“Charge depleting actual range or R_{cda} ” means the distance traveled on the Urban Charge Depleting Test Procedure at which the state of charge is first equal to the average state of charge of the two consecutive UDDS tests used to end the Urban Charge Depleting Test Procedure. This range must be accurate to the nearest 0.1 miles. (See section F.11.9.)

“Charge depletion depleting cycle range or R_{cdc} ” means the distance traveled on the Urban or Highway Charge Depleting Procedure up to the test cycle prior to where the state of charge is above the lower bound state of charge tolerance for one test cycle. This range will appear as the sum of a discrete number of test cycle distances. This range shall be accurate to the nearest 0.1 miles. (See section F.11.8.) achieved by a hybrid electric vehicle on a specified driving cycle at the point when the zero-emission energy storage device is depleted of off-vehicle charge and regenerative braking derived energy.

“Charge-sustaining” means that the battery of a hybrid electric vehicle ultimately does not fully discharge and impair vehicle operation as the vehicle continuously operates over a given driving cycle when no off-vehicle charging is performed and the consumable fuel is

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regularly replenished. Hybrid electric vehicles are required to be classified as either charge-sustaining or charge-depleting over each driving cycle (i.e. UDDS, HFEDS, US06, or SC03).

“Charge-sustaining net energy consumption” means the net electrical energy, Ecs, measured in watt-hours consumed by vehicle during charge sustaining operation. For charge sustaining operation, this number should be ~ 0.

“Charge-sustaining (CS) mode” means an operating mode in which the energy storage SOC may fluctuate but, on average, is maintained at a certain level while the vehicle is driven. Hybrid electric vehicles are required to be classified as either charge-sustaining or charge-depleting over each driving cycle (i.e. UDDS, HFEDS, US06, or SC03).

“Consumable fuel” means any solid, liquid, or gaseous matter that releases energy when consumed by an auxiliary power unit.

“Continuous Urban Test Schedule” means a repeated series comprised of an Urban Dynamometer Driving Schedules (UDDS), 40 CFR, Part 86, Appendix I, which is incorporated herein by reference; each test is followed by a 10 minute key off soak period.

“Continuous Highway Test Schedule” means a repeated series comprised of four consecutive key-on HFEDS schedules with 15 second key on pause in-between each, followed by a 10-20 minute key off soak period.

“Electric drive system” means an electric motor and associated power electronics, which provide acceleration torque to the drive wheels sometime during normal vehicle operation. This does not include components that could act as a motor, but are configured to act only as a generator or engine starter in a particular vehicle application.

“Electric range fraction” means the fraction of electrical energy derived from off-vehicle charging and regenerative braking energy relative to total traction energy used over the charge depletion range on a specified drive cycle.

“Enhanced AT PZEV” means any PZEV that has an allowance of 1.0 or greater per vehicle without multipliers and makes use of a ZEV fuel.

“Equivalent all electric range” means ~~the charge depletion range multiplied by the electric range fraction~~ (EAER = $R_{cd} \times ERF$) the total range timed the All Electric Range Fraction of the charge depleting range test. It represents the contribution of energy from the battery to the total energy used by the vehicle over the charge depleting range test.

“Fuel-fired heater” means a fuel burning device that creates heat for the purpose of warming the passenger compartment of a vehicle but does not contribute to the propulsion of the vehicle.

“Grid-connected hybrid electric vehicle” means a hybrid electric vehicle that has the capacity for the battery to be recharged from an off-board source of electricity and has some all-electric range.

“HFEDS” means highway fuel economy driving schedule. See 40 CFR Part 600 §600.109(b).

“Hybrid electric vehicle” or “HEV” means any vehicle that can draw propulsion energy from both of the following on-vehicle sources of stored energy: 1) a consumable fuel and 2) an energy storage device such as a battery, capacitor, or flywheel.

“Neighborhood Electric Vehicle” or “NEV” means a motor vehicle that meets the definition of “low-speed vehicle” either in section 385.5 of the Vehicle Code or in 49 CFR §571.500 (as it existed on July 1, 2000), and is certified to zero-emission vehicle standards.

“Off-vehicle charge capable” means having the capability to charge a battery from an off-vehicle electric energy source that cannot be connected or coupled to the vehicle in any

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manner while the vehicle is being driven. A grid-connected hybrid electric vehicle is one example of an off-vehicle charge capable hybrid electric vehicle.

“Placed in service” means having been sold or leased to an end-user and not just to a dealer or other distribution chain entity, and having been individually registered for on-road use by the California Department of Motor Vehicles.

“PZEV” means any vehicle that is delivered for sale in California and that qualifies for a partial ZEV allowance of at least 0.2.

“Regenerative braking” means the partial recovery of the energy normally dissipated into friction braking that is returned as electrical current to an energy storage device.

“SC03” means the U.S. EPA SC03 driving schedule representing vehicle operation with air conditioning, as set forth in Appendix I of 40 CFR Part 86.

“SOC Net Change Tolerance” means the state-of-charge net change tolerance that is applied to the SOC Criterion for charge-sustaining hybrid electric vehicles when validating an emission test. See section ~~D.8~~ E.9 and F.10 of these procedures for tolerance specifications.

“SOC Criterion” means the state-of-charge criterion that is applied to a charge-sustaining hybrid electric vehicle to validate an emission test. The SOC Criterion requires that no net change in battery energy occurs over a given test cycle, i.e. the final battery state-of-charge that is recorded at the end of the emission test must be equivalent to the initial battery state-of-charge that is set at the beginning of the emission test. The SOC Net Change Tolerance shall be applied to the SOC Criterion.

“Type 0, I, II, III, and IV ZEV” all have the meanings set forth in section C.4.4(a).

“US06” means the US06 driving schedule for aggressive driving as set forth in Appendix I of 40 CFR Part 86.

“UDDS” means urban dynamometer driving schedule as set forth Appendix I of 40 CFR Part 86.

“Zero-emission vehicle” or **“ZEV”** means any vehicle certified to zero-emission standards.

“Zero-emission VMT” means the vehicle miles traveled with zero exhaust emissions of any criteria pollutant (or precursor pollutant).

“ZEV fuel” means a fuel that provides traction energy in on-road ZEVs. Examples of current technology ZEV fuels include electricity, hydrogen, and compressed air.

2. Terminology

	<u>Abbreviation</u>	<u>Units</u>
<u>Charge Depleting Actual Range</u>	\underline{R}_{cda}	<u>mi</u>
<u>Charge Depleting to Charge Sustaining Range</u>	\underline{R}_{cdcs}	<u>mi</u>
<u>Charge Depleting Net Energy Consumption</u>	\underline{E}_{cd}	<u>wh</u>
<u>Charge Depleting CO₂ Produced</u>	\underline{M}_{cd}	<u>g</u>
<u>Charge Sustaining CO₂ Produced</u>	\underline{M}_{cs}	<u>g</u>
<u>CO₂ mass emissions of cold HFEDS charge sustaining test</u>	$\underline{H}_{coldcs}CO_2$	<u>g</u>
<u>CO₂ mass emissions of warm HFEDS charge sustaining test</u>	$\underline{H}_{warmcs}CO_2$	<u>g</u>
<u>Highway Charge Depleting Cycle Range</u>	\underline{R}_{cdch}	<u>mi</u>
<u>Highway Cold Start Correction Factor</u>	\underline{CF}_{cd}	<u>g</u>
<u>Highway Electric Range Fraction</u>	\underline{ERF}_h	<u>%</u>
<u>Highway Equivalent All-Electric Range</u>	\underline{EAER}_h	<u>mi</u>
<u>Highway Equivalent All-Electric Range Energy Consumption</u>	\underline{EAEREC}_h	<u>wh/mi</u>
<u>Urban Charge Depleting Cycle Range</u>	\underline{R}_{cdcu}	<u>mi</u>
<u>Urban Electric Range Fraction</u>	\underline{ERF}_u	<u>%</u>
<u>Urban Equivalent All-Electric Range</u>	\underline{EAER}_u	<u>mi</u>
<u>Urban Equivalent All-Electric Range Energy Consumption</u>	\underline{EAEREC}_u	<u>wh/mi</u>

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C. Zero-Emission Vehicle Standards.

1. **ZEV Emission Standard.** The Executive Officer shall certify new 2009 and subsequent model passenger cars, light-duty trucks, and medium-duty vehicles as ZEVs if the vehicles produce zero exhaust emissions of any criteria pollutant (or precursor pollutant) under any and all possible operational modes and conditions.

2. Percentage ZEV Requirements

2.1 General Percentage ZEV Requirement.

(a) *Basic Requirement.* The minimum percentage ZEV requirement for each manufacturer is listed in the table below as the percentage of the PCs and LDT1s, and LDT2s to the extent required by section C.2.2(c), produced by the manufacturer and delivered for sale in California that must be ZEVs, subject to the conditions in section C.2.2.

<i>Model Years</i>	<i>Minimum ZEV Requirement</i>
2009 through 2011	11 percent
2012 through 2014	12 percent
2015 through 2017	14 percent
2018 and subsequent	16 percent

(b) *Calculating the Number of Vehicles to Which the Percentage ZEV Requirement is Applied.* A manufacturer's production volume of PCs and LDT1s, and LDT2s as applicable, produced and delivered for sale in California to comply with a given model year ZEV requirement will be based on a three-year average of the manufacturer's volume of PCs and LDT1s, and LDT2s as applicable, produced and delivered for sale in California in the prior fourth, fifth and sixth years (e.g. 2010 model-year ZEV requirements will be based on California production volumes of PCs and LDT1s, and LDT2s as applicable, for the 2004 to 2006 model years). This production averaging is used to determine ZEV requirements only, and has no effect on a manufacturer's size determination. As an alternative to the three year averaging of prior year production described above, a manufacturer may elect to base its ZEV obligation on the number of PCs and LDT1s, and LDT2s to the extent required by section C.2.1(c), produced by the manufacturer and delivered for sale in California that same model year. In applying the ZEV requirement, a PC, LDT1, or LDT2 as applicable, that is produced by a small volume manufacturer, but is marketed in California by another manufacturer under the other manufacturer's nameplate, shall be treated as having been produced by the marketing manufacturer.

(c) *Phase-in of ZEV Requirements for LDT2s.* Beginning with the ZEV requirements for the 2009 model year, a manufacturer's LDT2 production shall be included in determining the manufacturer's overall ZEV requirement under section C.2.1(a) in the increasing percentages shown in the table below.

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2009	2010	2011	2012+
51%	68%	85%	100%

(d) *Exclusion of ZEVs in Determining a Manufacturer's Sales Volume.* In calculating for purposes of section C2.1(b) and (c) the volume of PCs, LDT1s, and LDT2s a manufacturer has produced and delivered for sale in California, the manufacturer shall exclude the number of ZEVs produced by the manufacturer, or by a subsidiary in which the manufacturer has a greater than 50% ownership interest, and delivered for sale in California.

2.2 Requirements for Large Volume Manufacturers.

(a) *Primary Requirements for Large Volume Manufacturers through Model Year 2011.* In the 2009 through 2011 model years, a large-volume manufacturer must meet at least 22.5 percent of its ZEV requirement with ZEVs or ZEV credits generated by such vehicles, and at least another 22.5 percent with ZEVs, advanced technology PZEVs, or credits generated by such vehicles. The remainder of the large-volume manufacturer's ZEV requirement may be met using PZEVs or credits generated by such vehicles.

(b) *Alternative Requirements for Large Volume Manufacturers.*

(1) *Minimum Floor for Production of Type III ZEVs.*

(A) [RESERVED]

(B) *Requirement for the 2009-2011 Model Years.* A large volume manufacturer electing to be subject to the alternative compliance requirements during model years 2009 through 2011 must produce, deliver for sale, and place in service in California enough 2009-2011 model-year Type III ZEVs to generate ZEV credits sufficient to meet a cumulative percentage ZEV requirement of ~~0.65~~ 0.80 percent of the manufacturer's average annual California sales of PCs, ~~and LDT1s, and 68 percent of LDT2s~~ over the three year period from model years ~~2003 2004~~ through ~~2005 2006~~, or submit an equivalent number of credits generated by such vehicles. The manufacturer may meet this requirement with ~~4~~ 2009-2011 model-year Type I, I.5, or ~~Type II~~ ZEVs, provided that 2 Type I ZEVs or 1.6 Type I.5 ZEVs or 1.33 Type II ZEVs or 0.8 Type IV ZEVs will equal one Type III ZEV.

(C) [RESERVED]

(D) [RESERVED]

(E) [RESERVED]

(F) *Exclusion of Additional Credits for Transportation Systems.* Any additional credits for transportation systems generated in accordance with section C.7.5 shall not be counted towards compliance with ~~this~~ section C.2.2(b)(1)(B).

(G) *Carry-over of Excess Credits.* ZEV credits generated from excess production in model years 2005 through 2008 may be carried forward and applied to the 2009 through 2011 minimum floor requirement specified in 1962.1(b)(2)(B)1.b. provided that the value of these carryover credits shall be based on the model year in which the credits are used. Beginning ~~in~~ with the 2012 model year, these credits may no longer be used to meet the ZEV requirement; they may be used as Enhanced AT PZEV, AT PZEV, or PZEV credits. ZEV credits earned in model year 2009 and subsequent would be allowed to be carried forward for two years for application to the ZEV requirement. For example, ZEV credit earned in the 2010 model year would retain full flexibility through the 2012 model year, at which time that credit could only be used as Enhanced AT PZEV, AT PZEV, or PZEV credits, and could not be used to satisfy the ZEV credit obligation, which may only be satisfied with credit generated from ZEVs.

(H) *Failure to Meet Requirement for Production of Type III ZEVs.* A manufacturer that, after electing to be subject to the alternative requirements in section C.2.2(b) for any model year from 2009 through 2011, fails to meet the requirement in section C.2.2(b)(1)(B) by the end of the specified three year period in which the model year falls, shall be treated as subject to the primary requirements in section C.2.1(a) for all model years in the specified three year period.

(I) *Rounding Convention.* The number of Type III ZEVs needed for a manufacturer under section C.2.2(b)(1)(B) shall be rounded to the nearest whole number.

(2) *Compliance With Percentage ZEV Requirements.* In the 2009 through 2011 model years, a large volume manufacturer electing to be subject to the alternative compliance requirements in a given model year must meet at least 45 percent of its ZEV requirement for that model year with ZEVs, advanced technology PZEVs, or credits generated from such vehicles. The remainder of the large volume manufacturer's ZEV requirement may be met using PZEVs or credits generated from such vehicles.

(3) *Sunset of Alternative Requirements After the 2011 Model Year.* The alternative requirements in section C.2.2(b) are not available after the 2011 model year.

(c) *Election of the Primary or Alternative Requirements for Large Volume Manufacturers.* A large volume manufacturer shall be subject to the primary ZEV requirements for the 2009 model year unless it notifies the Executive Officer in writing prior to the start of the 2005 model year that it is electing to be subject to the alternative compliance requirements for that model year. Thereafter, a manufacturer shall be subject to the same compliance option as applied in the previous model year unless it notifies the Executive Officer in writing prior to the start of a new model year that it is electing to switch to the other compliance option for that new model year. However, a large volume manufacturer that has previously elected to be subject to

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the primary ZEV requirements for one or more of the model years in the three year periods identified in section C.2.2(b)(1)(A)-(D) may prior to the end of the three year period elect to become subject to the alternative compliance requirements for the full three year period upon a demonstration that it has complied with all of the applicable requirements for that period in section C.2.2(b)(1)(B).

(d) *Requirements for Large Volume Manufacturers in Model Years 2012 through 2017.* In the 2012 through 2017 model years, a large-volume manufacturer must meet the ZEV total percent requirement as shown in the table below with ZEVs or ZEV credits generated by such vehicles. The entire requirement may be met solely with ZEVs. Optionally, a manufacturer may choose to meet or exceed the minimum ZEV floor and then satisfy the remainder of the manufacturer requirement using Enhanced AT PZEVs, AT PZEVs, and PZEVs. The following table enumerates the total percent ZEV requirement and the maximum component percentages for the optional Enhanced AT PZEV, AT PZEV, and PZEV categories that may be used to meet the total percentage ZEV requirement.

Years	Total ZEV Percent Requirement	Minimum ZEV floor percentage range	Enhanced AT PZEVs percentage range	AT PZEVs	PZEVs up to
2012 – 2014	12	0.3 – 3.0	0.0 – 2.7	3.0	6.0
2015 – 2017	14	3.0 – 6.0	0.0 – 3.0	2.0	6.0

(e) *Requirements for Large Volume Manufacturers in Model Years 2018 and Subsequent.* In the 2018 and subsequent model years, a large-volume manufacturer must meet a ZEV total percent requirement of 16 percent. The maximum portion of a large volume manufacturer's percentage ZEV requirement that may be satisfied by PZEVs that are not advanced technology PZEVs, or credits generated by such vehicles, is limited to 6 percent of the manufacturer's applicable California PC, LDT1, and LDT2 production volume; advanced technology PZEVs or credits generated by such vehicles may be used to meet up to one-half of the manufacturer's remaining ZEV requirement.

2.3 Requirements for Intermediate Volume Manufacturers. In 2009 and subsequent model years, an intermediate volume manufacturer may meet its ZEV requirement with up to 100 percent PZEVs or credits generated by such vehicles.

2.4 Requirements for Small Volume Manufacturers and Independent Low Volume Manufacturers. A small volume manufacturer or an independent low volume manufacturer is not required to meet the percentage ZEV requirements. However, a small volume manufacturer or an independent low volume manufacturer may earn and market credits for the ZEVs or PZEVs it produces and delivers for sale in California.

2.5 Counting ZEVs and PZEVs in Fleet Average NMOG Calculations. For purposes of calculating a manufacturer's fleet average NMOG value and NMOG credits under sections ~~1960.1(g)(2)~~ and 1961(b) and (c), title 13, CCR, a vehicle certified as a ZEV is counted

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as one ZEV, and a PZEV is counted as one SULEV certified to the 150,000 mile standards, regardless of any ZEV or PZEV multipliers.

2.6 [RESERVED]

2.7 Changes in Small Volume, Independent Low Volume, and Intermediate Volume Manufacturer Status.

(a) *Increases in California Production Volume.* In 2009 and subsequent model years, if a small volume manufacturer's average California production volume exceeds 4,500 units of new PCs, LDTs, and MDVs based on the average number of vehicles produced and delivered for sale for the three previous consecutive model years, or if an independent low volume manufacturer's average California production volume exceeds 10,000 units of new PCs, LDTs, and MDVs based on the average number of vehicles produced and delivered for sale for the three previous consecutive model years, the manufacturer shall no longer be treated as a small volume, or independent low volume manufacturer, as applicable, and shall comply with the ZEV requirements for independent low volume or intermediate volume manufacturers, as applicable, beginning with the sixth model year after the last of the three consecutive model years.

If an intermediate volume manufacturer's average California production volume exceeds 60,000 units of new PCs, LDTs, and MDVs based on the average number of vehicles produced and delivered for sale for the three previous consecutive model years, the manufacturer shall no longer be treated as an intermediate volume manufacturer and shall, beginning with the sixth model year after the last of the three consecutive model years, meet the ZEV requirements with PZEVs, of which at least one-fourth would have to be AT PZEVs and shall, beginning with the ninth model year after the last of the three consecutive model years, meet the ZEV regulation requirements with PZEVs, of which at least one-third would have to be AT PZEVs. The manufacturer would comply with all ZEV requirements for large volume manufacturers beginning with the twelfth model year after the last of the three consecutive model years.

The lead time shall be four rather than six years ~~where~~ when a manufacturer ceases to be a small or intermediate volume manufacturer in 2003 or subsequent years due to the aggregation requirements in majority ownership situations, except that if the majority ownership in the manufacturer was acquired prior to the 2001 model year, the manufacturer must comply with the stepped-up ZEV requirements starting in the 2010 model year.

(b) *Decreases in California Production Volume.* If a manufacturer's average California production volume falls below 4,500, 10,000, or 60,000 units of new PCs, LDTs, and MDVs, as applicable, based on the average number of vehicles produced and delivered for sale for the three previous consecutive model years, the manufacturer shall be treated as a small volume, independent low volume, or intermediate volume manufacturer, as applicable, and shall be subject to the requirements for a small volume, independent low volume, or intermediate volume manufacturer beginning with the next model year. In determining small volume manufacturer status, vehicles produced by one manufacturer and marketed in California by another manufacturer under the other manufacturer's nameplate shall be treated as part of the California production volume of the sales of the marketing manufacturer.

(c) *Calculating California Production Volume in Change of Ownership Situations.*

Where a manufacturer experiences a change in ownership in a particular model year, the change will affect application of the aggregation requirements on the manufacturer starting with the next model year. The manufacturer's small or intermediate volume manufacturer status for the next model year shall be based on the average California production volume in the three previous consecutive model years of those manufacturers whose production volumes must be aggregated for that next model year. For example, where a change of ownership during the 2010 model year results in a requirement that the production volume of Manufacturer A be aggregated with the production volume of Manufacturer B, Manufacturer A's status for the 2011 model year will be based on the production volumes of Manufacturers A and B in the 2008-2010 model years. Where the production volume of Manufacturer A must be aggregated with the production volumes of Manufacturers B and C for the 2010 model year, and during that model year a change in ownership eliminates the requirement that Manufacturer B's production volume be aggregated with Manufacturer A's, Manufacturer A's status for the 2011 model year will be based on the production volumes of Manufacturers A and C in the 2008-2010 model years. In either case, the lead time provisions in section 2.5(a) and (b) will apply.

3. Partial ZEV Allowance Vehicles (PZEVs).

3.1 Introduction. This section C.3 sets forth the criteria for identifying vehicles delivered for sale in California as PZEVs. A PZEV is a vehicle that cannot be certified as a ZEV but qualifies for a PZEV allowance of at least 0.2.

3.2 Baseline PZEV Allowance. In order for a vehicle to be eligible to receive a PZEV allowance, the manufacturer must demonstrate compliance with all of the following requirements. A qualifying vehicle will receive a baseline PZEV allowance of 0.2.

(a) *SULEV Standards.* Certify the vehicle to the 150,000-mile SULEV exhaust emission standards for PCs and LDTs in section 1961(a)(1), title 13, CCR. Bi-fuel, fuel-flexible and dual-fuel vehicles must certify to the applicable 150,000-mile SULEV exhaust emission standards when operating on both fuels;

(b) *Evaporative Emissions.* Certify the vehicle to the evaporative emission standards in section 1976(b)(1)(E), title 13, CCR (zero-fuel evaporative emissions standards);

(c) *OBD.* Certify that the vehicle will meet the applicable on-board diagnostic requirements in section 1968.1 or 1968.2, title 13, CCR for 150,000 miles; and

(d) *Extended Warranty.* Extend the performance and defects warranty period set forth in sections 2037(b)(2) and 2038(b)(4) to 15 years or 150,000 miles, whichever occurs first, except that the time period is to be 10 years for a zero emission energy storage device used for traction power (such as a battery, ultracapacitor, or other electric storage device).

3.3 Zero-Emission VMT PZEV Allowance.

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(a) *Calculation of Zero Emission VMT Allowance.* A vehicle that meets the requirements of section C.3.2 and has zero-emission vehicle miles traveled (“VMT”) capability will generate an additional zero emission VMT PZEV allowance, calculated as follows:

<i>Urban Equivalent All-Electric Range (EAER_u)</i>	<i>Zero-emission VMT Allowance</i>
< 10 miles	0.0
10 miles to 100 miles	$EAER_u \times (1 - UF_{R_{cda}})/14.6$
> 100 miles	1.58

The urban equivalent all-electric range (EAER_u) and urban charge depletion ~~depleting actual~~ range (R_{cda}) shall be determined in accordance with sections ~~F.11 and E.3.(2)(a)~~ F.5.5, respectively, of these test procedures. Utility Factor (UF) based on the urban charge depletion depleting actual range (R_{cda}) shall be determined according to the 0-100 mile 4th order curve fit from SAE J1711, issued March 1999, p52.

(b) *Alternative Procedures.* As an alternative to determining the zero-emission VMT allowance in accordance with the preceding section C.3.3(a), a manufacturer may submit for Executive Officer approval an alternative procedure for determining the zero-emission VMT potential of the vehicle as a percent of total VMT, along with an engineering evaluation that adequately substantiates the zero-emission VMT determination. For example, an alternative procedure may provide that a vehicle with zero-emissions of one regulated pollutant (e.g. NOx) and not another (e.g. NMOG) will qualify for a zero-emission VMT allowance of 1.5.

(c) [RESERVED]

3.4 PZEV Allowance for Advanced ZEV Componentry. A vehicle that meets the requirements of section C.3.2 may qualify for an advanced componentry PZEV allowance as provided in this section 3.4.

(a) *Use of High Pressure Gaseous Fuel or Hydrogen Storage System.* A vehicle equipped with a high pressure gaseous fuel storage system capable of refueling at 3600 pounds per square inch or more and operating exclusively on this gaseous fuel shall qualify for an advanced componentry PZEV allowance of 0.2. A vehicle capable of operating exclusively on hydrogen stored in a high pressure system capable of refueling at 3600 pounds per square inch or more, or stored in nongaseous form, shall instead qualify for an advanced componentry PZEV allowance of 0.3.

(b) *Use of a Qualifying HEV Electric Drive System.*

(1) *Classification of HEVs.* HEVs qualifying for additional advanced componentry PZEV allowance or allowances that may be used in the AT PZEV category are classified in one of four types of HEVs based on the criteria in the following table.

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HEVs must qualify for the Zero Emission VMT allowance in section 3.3(a) of this document and achieve 10 miles or more of all electric UDDS range in addition to meeting the requirements in the following table to qualify for Type F advanced componentry allowance.

<i>Characteristics</i>	<i>Type C</i>	<i>Type D</i>	<i>Type E</i>	<i>Type F</i>
Electric Drive System Peak Power Output	≥ 10 kW	≥ 10 kW	≥ 50 kW	Zero Emission VMT allowance; ≥ 10 mile all-electric range
Traction Drive System Voltage	< 60 Volts	≥ 60 Volts	≥ 60 Volts	≥ 60 Volts
Traction Drive Boost	Yes	Yes	Yes	Yes
Regenerative Braking	Yes	Yes	Yes	Yes
Idle Start/Stop	Yes	Yes	Yes	Yes

(2) [RESERVED]

(3) [RESERVED]

(4) *Type C HEVs.* A PZEV that the manufacturer demonstrates to the reasonable satisfaction of the Executive Officer meets all of the criteria for a Type C HEV, and that is equipped with an advanced traction energy storage system – such as lithium ion batteries, nickel metal-hydride batteries, ultracapacitors, or other similar systems – with a design lifetime of at least 10 years, qualifies for an additional advanced componentry allowance of 0.2 in the 2009 through 2011 model years, 0.15 in the 2012 through 2014 model years, and 0.1 in the 2015 and subsequent model years.

(5) *Type D HEVs.* A PZEV that the manufacturer demonstrates to the reasonable satisfaction of the Executive Officer meets all of the criteria for a Type D HEV qualifies for an additional advanced componentry allowance of 0.4 in the 2009 through 2011 model years, 0.35 in the 2012 through 2014 model years, and 0.25 in the 2015 and subsequent model years.

(6) *Type E HEVs.* A PZEV that the manufacturer demonstrates to the reasonable satisfaction of the Executive Officer meets all of the criteria for a Type E HEV qualifies for an additional advanced componentry allowance of 0.5 in the 2009 through 2011 model years, 0.45 in the 2012 through 2014 model years, and 0.35 in the 2015 and subsequent model years.

(7) *Type F HEVs.* A PZEV that the manufacturer demonstrates to the reasonable satisfaction of the Executive Officer meets all of the criteria for a Type F HEV qualifies for an additional advanced componentry allowance of 0.85 in the 2009 through 2011 model years, 0.8 in the 2012 through 2014 model years, and 0.7 in the 2015 and subsequent model years.

(8) *Severability.* In the event that all or part of section C.3.4(b)(1)-(7) is found invalid, the remainder of these standards and test procedures, including the remainder of section C.3.4(b)(1)-(7), remains in full force and effect.

3.5 PZEV Allowance for Low Fuel-Cycle Emissions. A vehicle that makes exclusive use of fuel(s) with very low fuel-cycle emissions shall receive a PZEV allowance not to exceed 0.3. In order to receive the PZEV low fuel-cycle emissions allowance, a manufacturer must demonstrate to the Executive Officer, using peer-reviewed studies or other relevant information, that NMOG emissions associated with the fuel(s) used by the vehicle (on a grams/mile basis) are lower than or equal to 0.01 grams/mile. Fuel-cycle emissions must be calculated based on near-term production methods and infrastructure assumptions, and the uncertainty in the results must be quantified.

3.6 Calculation of PZEV Allowance.

(a) *Calculation of Combined PZEV Allowance for a Vehicle.* The combined PZEV allowance for a qualifying vehicle in a particular model year is the sum of the PZEV allowances listed in this section C.3.6, multiplied by any PZEV introduction phase-in multiplier listed in section C.3.7, subject to the cap in section C.3.6.(b).

(1) *Baseline PZEV Allowance.* The baseline PZEV allowance of 0.2 for vehicles meeting the criteria in section C.3.2;

(2) *Zero Emission VMT PZEV Allowance.* The zero-emission VMT PZEV allowance, if any, determined in accordance with section C.3.3.;

(3) *Advanced ZEV Componentry PZEV Allowance.* The advanced ZEV componentry PZEV allowance, if any, determined in accordance with section C.3.4; and

(4) *Fuel-cycle Emissions PZEV Allowance.* The fuel-cycle emissions PZEV allowance, if any, determined in accordance with section C.3.5.

(b) *Caps on the Value of an AT PZEV Allowance.*

(1) *Cap for 2012 and Subsequent Model-Year Vehicles.* The maximum value an AT PZEV may earn before phase-in multipliers, including the baseline PZEV allowance, is 3.0.

(2) [RESERVED]

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3.7 PZEV Multipliers

(a) [RESERVED]

(b) *Introduction Phase-In Multiplier for PZEVs That Earn a Zero Emission VMT Allowance.* Each 2009 through 2011 model year PZEV that earns a zero emission VMT allowance under section C.3.3 and is produced and delivered for sale in California qualifies for a phase-in multiplier of 3.0.

4. Qualification for ZEV Multipliers and Credits.

4.1 [RESERVED]

4.2 [RESERVED]

4.3 [RESERVED]

4.4 ZEV Credits for 2009 and Subsequent Model Years.

(a) *ZEV Tiers for Credit Calculations.* ZEV credits from a particular ZEV are based on the assignment of a given ZEV into one of the following six ZEV tiers:

ZEV Tier	UDDS ZEV Range (miles)	Fast Refueling Capability
NEV	No minimum	N/A
Type 0	< 50 miles	N/A
Type I	≥ 50, < 75 miles	N/A
Type I.5	≥ 75, < 100 miles	N/A
Type II	≥ 100 miles	N/A
Type III OR	<u>either</u> <u>option</u>	≥ 100 miles Must be capable of replacing 95% maximum rated energy capacity in ≤ 10 minutes per section <u>C.4.4.(b)</u>
		≥ 200 N/A
Type IV	≥ 200	Must be capable of replacing 190 miles (UDDS ZEV range) in ≤ 15 minutes per section 1962.1(d)(5)(B) <u>C.4.4.(b)</u>

(b) *Fast Refueling.* The “fast refueling capability” requirement for a 2009 and subsequent model-year Type III or IV ZEV in section 1962(d)(5)(A) will be considered met if the Type III ZEV has the capability to accumulate at least 95 miles of UDDS range in 10 minutes or less and the Type IV ZEV has the capability to accumulate at least 190 miles in 15 minutes or less.

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(c) *ZEV Credits for 2009 and Subsequent Model-Year ZEVs.* A 2009 and subsequent model-year ZEV, other than a NEV or Type 0, earns 1 ZEV credit when it is produced and delivered for sale in California. A 2009 and subsequent model-year ZEV earns additional credits based on the earliest year in which the ZEV is placed in service (not earlier than the ZEV’s model year). The following table identifies the credits that a ZEV in each of the six ZEV tiers will earn, including the credit not contingent on placement in service, if it is placed in service in the specified model year or by June 30 after the end of the specified calendar year.

<i>Total Credit Earned by ZEV Type and Model Year for Production and Delivery for Sale and for Placement</i>		
<i>Tier</i>	<i>Model Year in Which ZEV is Placed in Service</i>	
	<i>2009 - 2017</i>	<i>2018 +</i>
NEV	0.30	0.30
Type 0	1	1
Type I	2	2
Type I.5	2.5	2.5
Type II	3	3
Type III	4	3
Type IV	5	3

(d) *Multiplier for Certain Type I and Type II ZEVs.* A 2009 through 2011 model-year Type I and Type II ZEV shall qualify for a multiplier of 1.25 if it is either sold to a motorist or is leased for three or more years to a motorist who is given the option to purchase or re-lease the vehicle for two years or more at the end of the first lease term.

(e) *Counting Specified ZEV Placed in a Section 177 State.* As specified in the table below, specified model year Type I, I.5, II, III or IV ZEVs that are certified to the California ZEV standards and are placed in service in a state that is administering the California ZEV requirements pursuant to section 177 of the federal Clean Air Act (42 U.S.C. §7507) applicable for the ZEV’s model year may be counted towards compliance with the California percentage ZEV requirements in section C.2, including the requirements in section C.2.2.(b), as if they were delivered for sale and placed in service in California. Similarly, specified model year Type I, I.5, II, III or IV ZEVs that are certified to the California ZEV standards and are placed in service in California may be counted towards the percentage ZEV requirements of any state that is

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administering the California ZEV requirements pursuant to section 177 of the federal Clean Air Act, including requirements based on section C.2.2.(b).

Vehicle Type	Through Model Year:
Type I, I.5, or II ZEV	2014
Type III or IV ZEV	2017

5. [Reserved]

6. [Reserved]

7. Generation and Use of ZEV Credits; Calculation of Penalties

7.1 Introduction. A manufacturer that produces and delivers for sale in California ZEVs or PZEVs in a given model year exceeding the manufacturer's ZEV requirement set forth in section C.2 shall earn ZEV credits in accordance with this section C.7.

7.2 ZEV Credit Calculations.

(a) *Credits from ZEVs.* The amount of g/mi ZEV credits earned by a manufacturer in a given model year from ZEVs shall be expressed in units of g/mi NMOG, and shall be equal to the number of credits from ZEVs produced and delivered for sale in California that the manufacturer applies towards meeting the ZEV requirements for the model year subtracted from the number of ZEVs produced and delivered for sale in California by the manufacturer in the model year and then multiplied by the NMOG fleet average requirement for PCs and LDT1s for that model year.

(b) *Credits from PZEVs.* The amount of g/mi ZEV credits from PZEVs earned by a manufacturer in a given model year shall be expressed in units of g/mi NMOG, and shall be equal to the total number of PZEV allowances from PZEVs produced and delivered for sale in California that the manufacturer applies towards meeting its ZEV requirement for the model year subtracted from the total number of PZEV allowances from PZEVs produced and delivered for sale in California by the manufacturer in the model year and then multiplied by the NMOG fleet average requirement for PCs and LDT1s for that model year.

(c) *Separate Credit Accounts.* The number of credits from a manufacturer's [i] ZEVs and [ii] advanced technology PZEVs, and [iii] all other PZEVs shall each be maintained separately.

7.3 ZEV Credits for MDVs and LDTs Other Than LDT1s. ZEVs and PZEVs classified as MDVs or as LDTs other than LDT1s may be counted toward the ZEV requirement for PCs, LDT1s, and LDT2s as applicable, and included in the calculation of ZEV credits as specified in this section C.4 if the manufacturer so designates.

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7.4 ZEV Credits for Advanced Technology Demonstration Programs. In model years 2009 through 2014, a vehicle, other than a NEV, which is placed in a California advanced technology demonstration program for a period of two or more years, may earn ZEV credits even if it is not “delivered for sale” or registered with the California Department of Motor Vehicles (DMV). To earn such credits, the manufacturer must demonstrate to the reasonable satisfaction of the Executive Officer that the vehicles will be regularly used in applications appropriate to evaluate issues related to safety, infrastructure, fuel specifications or public education, and that for 50 percent or more of the first two years of placement the vehicle will be situated in California. Such a vehicle is eligible to receive the same allowances and credits that it would have earned if placed in service. To determine vehicle credit, the model-year designation for a demonstration vehicle shall be consistent with the model-year designation for conventional vehicles placed in the same timeframe. Manufacturers may earn credit for as many as six vehicles under this section C.7.4. A manufacturer’s vehicles in excess of the six-vehicle cap will not be eligible for advanced technology demonstration program credits.

7.5 ZEV Credits for Transportation Systems.

(a) *General.* In model years 2009 and subsequent, a ZEV placed, for two or more years, as part of a transportation system may earn additional ZEV credits, which may be used in the same manner as other credits earned by vehicles of that category, except as provided in section C.7.5(c) below. In model years 2009 through 2011, an advanced technology PZEV or PZEV placed as part of a transportation system may earn additional ZEV credits, which may be used in the same manner as other credits earned by vehicles of that category, except as provided in section C.7.5(c) below. A NEV is not eligible to earn credit for transportation systems. To earn such credits, the manufacturer must demonstrate to the reasonable satisfaction of the Executive Officer that the vehicle will be used as a part of a project that uses an innovative transportation system as described in section C.7.5(b) below.

(b) *Credits Earned.* In order to earn additional credit under this section C.7.5, a project must at a minimum demonstrate [i] shared use of ZEVs, AT PZEVs or PZEVs, and [ii] the application of “intelligent” new technologies such as reservation management, card systems, depot management, location management, charge billing and real-time wireless information systems. If, in addition to factors [i] and [ii] above, a project also features linkage to transit, the project may receive further additional credit. For ZEVs only, not including NEVs, a project that features linkage to transit, such as dedicated parking and charging facilities at transit stations, but does not demonstrate shared use or the application of intelligent new technologies, may also receive additional credit for linkage to transit. The maximum credit awarded per vehicle shall be determined by the Executive Officer, based upon an application submitted by the manufacturer and, if appropriate, the project manager. The maximum credit awarded shall not exceed the following:

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<i>Type of Vehicle</i>	<i>Model Year</i>	<i>Shared Use, Intelligence</i>	<i>Linkage to Transit</i>
PZEV	through 2011	2	1
AT PZEV	through 2011	4	2
ZEV	2009 through 2011	6	3
ZEV	2012 and subsequent	2	1

(c) *Cap on Use of Credits.*

(1) *ZEVs.* Credits earned or allocated by ZEVs pursuant to this section C.7.5, not including all credits earned by the vehicle itself, may be used to satisfy up to one-tenth of a manufacturer’s ZEV obligation in any given model year.

(2) *AT PZEVs.* Credits earned or allocated by AT PZEVs pursuant to this section C.7.5, not including all credits earned by the vehicle itself, may be used to satisfy up to one-twentieth of a manufacturer’s ZEV obligation in any given model year, but may only be used in the same manner as other credits earned by vehicles of that category.

(3) *PZEVs.* Credits earned or allocated by PZEVs pursuant to this section C.7.5, not including all credits earned by the vehicle itself, may be used to satisfy up to one-fiftieth of the manufacturer’s ZEV obligation in any given model year, but may only be used in the same manner as other credits earned by vehicles of that category.

(d) *Allocation of Credits.* Credits shall be assigned by the Executive Officer to the project manager or, in the absence of a separate project manager, to the vehicle manufacturers upon demonstration that a vehicle has been placed in a project. Credits shall be allocated to vehicle manufacturers by the Executive Officer in accordance with a recommendation submitted in writing by the project manager and signed by all manufacturers participating in the project, and need not be allocated in direct proportion to the number of vehicles placed.

7.6 Use of ZEV Credits. A manufacturer may meet the ZEV requirements in any given model year by submitting to the Executive Officer a commensurate amount of g/mi ZEV credits consistent with section C.2. These credits may be earned previously by the manufacturer or acquired from another party, except that credits earned from NEVs offered for sale or placed in service in model years 2001 through 2005 cannot be used to satisfy more than 50 percent of a manufacturer’s percentage ZEV obligation that may only be satisfied with credits from ZEVs. The manufacturer’s percentage ZEV obligation that may be satisfied by credits from AT PZEVs but not PZEVs is listed in the table below:

<i>AT PZEV Category</i>	
<i>2009</i>	<i>2010 and beyond</i>
75%	50%

This limitation applies to credits earned in model years 2001 through 2005 by the same manufacturer or earned in model years 2001 through 2005 by another manufacturer and

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acquired. The amount of g/mi ZEV credits required to be submitted shall be calculated according to the criteria set forth in this section C. 7.

ZEV credits generated from excess production in model years 2009 and subsequent, including those acquired from another party, may be carried forward and applied to the ZEV minimum floor requirement specified in C.2.2.(b)(1)(B) for two subsequent model years. Beginning with the third subsequent model year, those earned ZEV credits may no longer be used to satisfy the manufacturer's percentage ZEV obligation that may only be satisfied by credits from ZEVs, but may be used to satisfy the manufacturer's percentage ZEV obligation that may be satisfied by credits from Enhanced AT PZEVs, AT PZEVs, or PZEVs. For example, ZEV credit earned in 2010 would retain full flexibility through 2012, at which time that credit could only be used as Enhanced AT PZEV, AT PZEV, or PZEV credits.

7.7 Requirement to Make Up a ZEV Deficit.

(a) *General.* A manufacturer that produces and delivers for sale in California fewer ZEVs than required in a given model year shall make up the deficit by the end of the third model year by submitting to the Executive Officer a commensurate amount of g/mi ZEV credits. The amount of g/mi ZEV credits required to be submitted shall be calculated by [i] adding the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year to the number of ZEV allowances from partial ZEV allowance vehicles produced and delivered for sale in California by the manufacturer for the model year (for a large volume manufacturer, not to exceed that permitted under section C.2.1), [ii] subtracting that total from the number of ZEVs required to be produced and delivered for sale in California by the manufacturer for the model year, and [iii] multiplying the resulting value by the fleet average requirements for PCs and LDT1s for the model year in which the deficit is incurred.

7.8 Penalty for Failure to Meet ZEV Requirements. Any manufacturer that fails to produce and deliver for sale in California the required number of ZEVs or submit an appropriate amount of g/mi ZEV credits and does not make up ZEV deficits within the specified time period shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer that sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the ZEV deficits are not balanced by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's standards shall be calculated according to the following equation, provided that the percentage of a large volume manufacturer's ZEV requirement for a given model year that may be satisfied with partial ZEV allowance vehicles or ZEV credits from such vehicles may not exceed the percentages permitted under section C.2.1:

(No. of ZEVs required to be produced and delivered for sale in California for the model year) - (No. of ZEVs produced and delivered for sale in California for the model year) - (No. of ZEV allowances from partial ZEV allowance vehicles produced and delivered for sale in California for the model year) - [(Amount of ZEV credits submitted for the model year) / (the fleet average requirement for PCs and LDT1s for the model-year)].

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8. Severability. Each provision of these standards and test procedures is severable, and in the event that any provision of these standards and test procedures is held to be invalid, the remainder of the standards and test procedures remains in full force and effect.

9. Public Disclosure. Records in the Board's possession for the vehicles subject to the requirements of section 1962.1, title 13, CCR shall be subject to disclosure as public records as follows:

(a) Each manufacturer's annual production data and the corresponding credits per vehicle earned for ZEVs (including ZEV type), Enhanced AT PZEVs, AT PEVs, and PZEVs for the 2009 and subsequent model years; and

(b) Annual Credit balances for 2010 and subsequent years for:

(1) Each type of vehicle: ZEVs (minus NEVs), NEVs, Enhanced AT PZEVs, AT PEVs, and PZEVs; and

(2) Advanced technology demonstration programs; and

(3) Transportation systems; and

(4) Credits earned under section 1962.1(d)(5)(C).

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D. Certification Requirements.

1. Durability and Emission Testing Requirements. All ZEVs are exempt from all mileage and service accumulation, durability-data vehicle, and emission-data vehicle testing requirements.

2. Information Requirements: Application for Certification. Except as noted below, the Part I (40 CFR §86.1843-01(c)) certification application shall include the following:

- 2.1 Identification and description of the vehicle(s) covered by the application.
- 2.2 Identification of the vehicle weight category to which the vehicle is certifying: PC, LDT 0-3750 lbs. LVW, LDT 3751-5750 lbs. LVW, LDT 3751 lbs. LVW - 8500 lbs. GVW, or MDV (state test weight range), and the curb weight and gross vehicle weight rating of the vehicle.
- 2.3 Identification and description of the propulsion system for the vehicle.
- 2.4 Identification and description of the climate control system used on the vehicle.
- 2.5 Projected number of vehicles produced and delivered for sale in California, and projected California sales.
- 2.6 Identification of the energy usage in kilowatt-hours per mile from:
 - (a) the battery output (DC energy) (to be submitted with the Part II certification application (40 CFR §86.1843-01(d));
 - (b) the point when electricity is introduced from the electrical outlet (AC energy); and
 - (c) the operating range in miles of the vehicle when tested in accordance with the All-Electric Range Test set forth in section E, below. For off-vehicle charge capable hybrid electric vehicles, the manufacturer shall provide the energy usage in kilowatt hours per mile from the Urban Equivalent All-Electric Range and the Highway Equivalent All-Electric Range.
- 2.7 For those ZEVs and HEVs that use fuel-fired heaters, the manufacturer shall provide:
 - (a) a description of the control system logic of the fuel-fired heater, including an evaluation of the conditions under which the fuel-fired heater can be operated and an evaluation of the possible operational modes and conditions under which evaporative emissions can exist;
 - (b) the exhaust emissions value per mile produced by the auxiliary fuel-fired heater operated between 68°F and 86°F; and
 - (c) the test plan which describes the procedure used to determine the mass emissions of the fuel-fired heater.

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2.8 All information necessary for proper and safe operation of the vehicle, including information on the safe handling of the battery system, emergency procedures to follow in the event of battery leakage or other malfunctions that may affect the safety of the vehicle operator or laboratory personnel.

2.9 Method for determining battery state-of-charge, battery charging capacity and recharging procedures, and any other relevant information as determined by the Executive Officer.

2.10 Battery specific energy data and calculations as specified in section E.4 of these procedures including the weight of the battery system and the three hour discharge rate (C/3) energy capacity.

2.11 Vehicle and battery break-in period as specified in section E.2 of these test procedures.

2.12 Labeling shall conform with the requirements specified in section 1965, title 13, CCR and the ~~California Motor Vehicle Emission Control and Smog Index Label Specifications~~ “California Environmental Performance Label Specifications for 2009 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles” (incorporated by reference therein).

2.13 For a ZEV, extended range HEV or PZEV that qualifies to receive one or more multipliers under sections C.3 - C.7, the manufacturer shall provide all information relevant to the vehicle’s qualification for, and the estimated value of, the multiplier(s). The Executive Officer may request additional information needed to appropriately characterize the vehicle. Based on the submitted information and other relevant data, the Executive Officer shall assign to the vehicle the highest multiplier(s) for which the manufacturer has demonstrated the vehicle qualifies at that time.

2.14 ~~Where~~ When a manufacturer plans to require any scheduled maintenance for a PZEV before 150,000 miles, the manufacturer must submit information demonstrating the need for each scheduled maintenance item before 150,000 miles, including actual in-use data, engineering evaluation of the durability of the part, or other relevant information. The manufacturer may require such maintenance for a PZEV only upon the Executive Officer’s determination, prior to certification, the manufacturer has demonstrated the need for the scheduled maintenance; this determination may not unreasonably be denied.

2.15 For off-vehicle charge capable hybrid electric vehicles, the manufacturer shall provide the Urban Charge Depleting Cycle Range, the Urban Charge Depleting Actual Range, the Charge Depleting to Charge Sustaining Urban Range, the Highway Charge Depleting Cycle Range, the Highway Charge Depleting Actual Range, the Charge Depleting to Charge Sustaining Highway Range, the Urban Equivalent All-Electric Range, the Highway Equivalent All-Electric Range, the Urban Electric Range Fraction, and the Highway Electric Range Fraction.

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3. ZEV Reporting Requirements. In order to verify the status of each manufacturer's compliance with the ZEV requirements for a given calendar year, each manufacturer shall submit a report to the Executive Officer at least annually, by May 1 of the calendar year following the close of the model year, that identifies the necessary delivery and placement data of all vehicles generating ZEV credits or allowances, and all transfers and acquisitions of ZEV credits. The manufacturer may update the report by September 1 to cover activities occurring between April 1 and June 30.

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E. Test Procedures for Zero-Emission Vehicles and All Hybrid-Electric Vehicles, Except Off-Vehicle Charge Capable.

The “as adopted or amended dates” of the 40 CFR Part 86 regulations referenced by this document are the dates identified in the “California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,” ~~incorporated by reference in section 1961(d), title 13, CCR. Unless otherwise noted, these requirements shall apply to both ZEVs and all HEVs, except off-vehicle charge capable HEVs.~~

1. Electric Dynamometer. All ZEVs and HEVs must be tested using a 48-inch single roll electric dynamometer meeting the requirements of 40 CFR Subpart B, §86.108-00(b)(2) [October 22, 1996].

2. Vehicle and Battery Break-In Period. A manufacturer shall use good engineering judgment in determining the proper stabilized emissions mileage test point and report same according to the requirements of section D.2.11 above.

3. All-Electric Range Test for Zero-Emission Vehicles. All ~~2004~~ 2011 and subsequent ZEVs ~~and only off-vehicle charge capable hybrid electric vehicles~~ shall be subject to the All-Electric Range Test specified below for the purpose of determining the energy efficiency and operating range of a the ZEV ~~or of an off-vehicle charge capable hybrid electric vehicle operating without the use of its auxiliary power unit. For hybrid electric vehicles, the manufacturer may elect to conduct the All Electric Range Test prior to vehicle preconditioning in the exhaust and evaporative emission test sequence specified in the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles” as incorporated by reference in section 1976, Title 13, CCR.~~

~~3.1 — Cold soak. The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle’s battery shall be charged to a full state of charge.~~

~~3.2 — Driving schedule.~~

3.2.1 Determination of Urban All-Electric Range-Urban for Zero-Emission Vehicles.

(a) Cold soak. The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle’s battery shall be charged to a full state-of-charge. Charge time shall not exceed soak time.

~~(a)~~ At the end of the cold soak period, the vehicle shall be placed, ~~either driven or~~ pushed, onto a dynamometer and operated through successive Urban Dynamometer Driving Schedules (UDDS), 40 CFR, Part 86, Appendix I [July 13, 2005], which is incorporated herein by reference. A 10-minute soak shall follow each UDDS cycle.

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(bc) For vehicles with a maximum speed greater than or equal to the maximum speed on the UDDS cycle, this test sequence shall be repeated until the vehicle is no longer able to maintain either the speed or time tolerances in 40 CFR §86.115-00 (b)(1) and (2) [October 22, 1996], or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc. ~~For off-vehicle charge capable hybrid electric vehicles, this determination shall be performed without the use of the auxiliary power unit.~~

(ed) For vehicles with a maximum speed less than the maximum speed on the UDDS cycle, the vehicle shall be operated at maximum available power (or full throttle) when the vehicle cannot achieve the speed trace within the speed and time tolerances specified in 40 CFR §86.115-00(b)(1) and (2) [October 22, 1996]. The test shall be terminated when the vehicle speed when operated at maximum available power (or full throttle) falls below 95 percent of the maximum speed initially achieved on the UDDS cycle or when the battery state-of-charge is depleted to the lowest level allowed by the manufacturer, or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc., whichever occurs first. For off-vehicle charge capable hybrid electric vehicles, this determination shall be performed without the use of the auxiliary power unit.

3.2.2 Determination of Highway All-Electric Range -Highway for Zero-Emission Vehicles.

(a) Cold soak. The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state-of-charge. Charge time shall not exceed soak time.

(ab) At the end of the cold soak period, the vehicle shall be placed, either driven or pushed, onto a dynamometer and operated through two successive Continuous Highway Fuel Economy Driving Test Schedules (HFEDS), 40 CFR, Part 600, Appendix I [September 12, 1977], which is incorporated herein by reference. There shall be a 15 second zero speed with key on and brake depressed between two cycles and a 10-minute soak following the two HFEDS cycles.

(bc) For vehicles with a maximum speed greater than or equal to the maximum speed on the Highway Fuel Economy Driving Schedule (HFEDS) cycle, this test sequence shall be repeated until the vehicle is no longer able to maintain either the speed or time tolerances in 40 CFR §86.115-00 (b)(1) and (2) [October 22, 1996], or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc. ~~For off-vehicle charge capable hybrid electric vehicles, this determination is optional and shall be performed without the use of the auxiliary power unit.~~

(ed) For vehicles with a maximum speed less than the maximum speed on the HFEDS cycle, the vehicle shall be operated at maximum available power (or full throttle) when the vehicle cannot achieve the speed trace within the speed and time tolerances specified in 40 CFR §86.115-00(b)(1) and (2) [October 22, 1996]. The test shall be terminated when the vehicle

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speed when operated at maximum available power (or full throttle) falls below 95 percent of the maximum speed initially achieved on the HFEDS cycle or when the battery state-of-charge is depleted to the lowest level allowed by the manufacturer, or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc., whichever occurs first. ~~For off-vehicle charge capable hybrid electric vehicles, this determination shall be performed without the use of the auxiliary power unit.~~

(de) NEVs are exempt from the all-electric range highway test.

3.2.3 Recording requirements.

For all electric vehicles and hybrid electric vehicles, except off-vehicle charge capable hybrid electric vehicles: Once the vehicle is no longer able to maintain the speed and time requirements specified in E.3.1 or E.3.2 (2) above, ~~or once the auxiliary power unit turns on, in the case of an off-vehicle charge capable hybrid electric vehicle,~~ the vehicle shall be brought to an immediate stop and the following data shall be recorded:

- (a) mileage accumulated during the All-Electric Range Test;
- (b) Net DC energy from the battery that was expended during the All-Electric Range Test (may be reported as the total DC battery energy output and the total DC battery energy input during the All-Electric Range Test);
- (c) AC energy required to fully charge the battery after the All-Electric Range Test from the point where electricity is introduced from the electric outlet to the battery charger; and
- (d) DC energy required to fully charge the battery after the All-Electric Range Test from the point where electricity is introduced from the battery charger to the battery.

Battery charging shall begin within 1 hour after terminating the All-Electric Range Test.

3.2.4 **Regenerative braking.** Regenerative braking systems may be utilized during the range test. The braking level, if adjustable, shall be set according to the manufacturer's specifications prior to the commencement of the test. The driving schedule speed and time tolerances specified in E.3.1 or E.3.2 (2) shall not be exceeded due to the operation of the regenerative braking system.

3.5 Measurement Accuracy. The overall error in voltage and current recording instruments shall not exceed 1% of the maximum value of the variable being measured. Suggested equipment: clamp-on amp meter/power meter capable of sampling voltage and current. Voltage and current shall be sampled at a minimum rate of 20 hz.

3.6 Watt Hour Calculation.

DC energy (watt hours) shall be calculated as follows

$$\text{DC energy} = \int v(t) * i(t) dt$$

Where v = vehicle DC main battery pack voltage
 i = vehicle DC main battery pack current

4. Determination of Battery Specific Energy for ZEVs.

Determine the specific energy of batteries used to power a ZEV in accordance with the U.S. Advanced Battery Consortium's Electric Vehicle Battery Procedure Manual (January 1996), Procedure No. 2, "Constant Current Discharge Test Series," using the C/3 rate. The weight calculation must reflect a completely functional battery system as defined in the Appendix of the Manual, including pack(s), required support ancillaries (e.g., thermal management), and electronic controller.

5. Determination of the Emissions of the Fuel-fired Heater.

The exhaust emissions result of the fuel-fired heater shall be determined by operating at a maximum heating capacity with a cold start between 68°F and 86°F for a period of 20 minutes and dividing the grams of emissions by 20. The resulting grams per minute shall be multiplied by 3.0 minutes per mile ~~for~~ to obtain a grams per mile value.

6. ~~Hybrid Electric Vehicle FTP Urban Emission Test Provisions for All Hybrid Electric Vehicles, Except Off-Vehicle Charge Capable.~~

Alternative procedures may be used if shown to yield equivalent results and if approved in advance by the Executive Officer of the Air Resources Board.

6.1 Vehicle Preconditioning.

To be conducted pursuant to the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" ~~as incorporated by reference herein~~ with the following supplemental requirements:

~~6.1.1 Battery state-of-charge shall be set prior to initial fuel drain and fill before vehicle preconditioning.~~

6.1.21 For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the preconditioning drive.

6.1.32 For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

- (i) If the hybrid electric vehicle is charge-sustaining over the UDDS, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

- (ii) If the hybrid electric vehicle is charge-depleting over the UDDS, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in urban driving conditions.

6.1.43 After setting battery state-of-charge, the hybrid electric vehicle shall be pushed or towed to a work area for the initial fuel drain and fill according to sections III.D.1.14. and D.1.2. of the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles,” ~~as incorporated by reference herein.~~

6.1.54 Following the initial fuel drain and fill, the vehicle shall complete an initial soak period of a minimum of 6 hours. After completing the soak period, the vehicle shall be pushed or towed into position on a dynamometer and preconditioned. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the preconditioning drive.

6.1.65 Within five minutes of completing preconditioning drive, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

- (i) If the hybrid electric vehicle does not allow manual activation of the auxiliary power unit and is charge-sustaining over the UDDS, then set battery state-of-charge to a level such that the SOC Criterion (see section B., Definitions and Terminology, of these procedures) would be satisfied for the dynamometer procedure (section E.6.2 of these procedures). If off-vehicle charging is required to increase battery state-of-charge for proper setting, off-vehicle charging shall occur during the second soak period of 12 to 36 hours ~~soak period.~~
- (ii) If the hybrid electric vehicle does not allow manual activation of the auxiliary power unit and is charge-depleting over the UDDS, then no battery state-of-charge adjustment is permissible.
- (iii) If the hybrid electric vehicle does allow manual activation of the auxiliary power unit, then set battery state-of-charge to manufacturer recommended level for activating the auxiliary power unit when the hybrid electric vehicle is operating in urban driving conditions.

6.2 Urban Dynamometer Procedure for All Hybrid Electric Vehicles, Except Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §86.135-00 [October 22, 1996] with the following revisions: References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

6.2.1 Amend subparagraph (a):

Overview. The dynamometer run shall consist of two tests, a “cold” start test, after a second fuel drain and fill and a 12 to 36 hour soak period performed

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~~minimum 12-hour and a maximum 36-hour soak~~ pursuant to the provisions of the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles,” ~~as incorporated by reference herein,~~ and a “hot” start test following the “cold” start test by 10 minutes. Vehicle startup (with all accessories turned off), operation over the UDDS and vehicle shutdown make a complete cold start test. Vehicle startup and operation over the UDDS and vehicle shutdown make a complete hot start test.

For all UDDS tests, ~~t~~The exhaust emissions are diluted with ambient air in the dilution tunnel as shown in Figure B94-5 and Figure B94-6 (§86.110-94). A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. Four particulate samples are collected on filters for weighing; the first sample plus backup is collected during the cold start test (including shutdown); the second sample plus backup is collected during the hot start test (including shutdown). Continuous proportional samples of gaseous emissions are collected for analysis during each test. For hybrid electric vehicles with ~~gasoline-fueled, natural gas-fueled and liquefied petroleum gas-fueled~~ Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO₂, CH₄ and NO_x. For hybrid electric vehicles that are not “off-vehicle charge capable,” and are equipped with petroleum-fueled diesel-cycle auxiliary power units (optional for natural gas-fueled, liquefied petroleum gas-fueled, and ~~methanol~~ alcohol-fueled diesel-cycle vehicles), THC is sampled and analyzed continuously pursuant to the provisions of §86.110-94. Parallel samples of the dilution air are similarly analyzed for THC, CO, CO₂, CH₄ and NO_x. For hybrid electric vehicles with natural gas-fueled, liquefied petroleum gas-fueled, and ~~methanol~~ alcohol-fueled auxiliary power units, bag samples are collected and analyzed for THC (if not sampled continuously), CO, CO₂, CH₄ and NO_x. For hybrid electric vehicles with ~~methanol~~ alcohol-fueled auxiliary power units, ~~methanol~~ alcohol and formaldehyde samples are taken for both exhaust emissions and dilution air (a single dilution air formaldehyde sample, covering the total test period may be collected). Parallel bag samples of dilution air are analyzed for THC, CO, CO₂, CH₄ and NO_x.

6.2.2 Subparagraphs (b) through (c). [No change.]

~~6.2.23~~ Delete subparagraph (d).

6.2.4 Subparagraphs (e) through (g). [No change.]

6.2.35 Amend subparagraph (h): The driving distance, as measured by counting the number of dynamometer roll or shaft revolutions, shall be determined for the cold start test and hot start test. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle’s speed.

6.2.6 Subparagraph (i). [No change.]

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6.3 Urban Dynamometer Test Run, Gaseous and Particulate Emissions for All Hybrid Electric Vehicles, Except Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §86.137-96 [March 24, 1993] with the following revisions:

6.3.1 Amend subparagraph (a): *General*. The dynamometer run shall consist of two tests, a “cold” start test, after a second fuel drain and fill and a 12 to 36 hour soak period performed ~~minimum 12 hour and a maximum 36 hour soak~~ pursuant to the provisions of the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles,” ~~as incorporated by reference herein,~~ and a “hot” start test following the cold start test by 10 minutes. The complete dynamometer test consists of a cold start drive of 7.5 miles (12.1 km) and a hot start drive of 7.5 miles (12.1 km). The vehicle shall be stored prior to the emission test in such a manner that precipitation (e.g., rain or dew) does not occur on the vehicle. The vehicle is allowed to stand on the dynamometer during the 10 minute time period between ~~the cold and hot start~~ each tests.

6.3.2 Amend subparagraph (b) as follows.

6.3.2.1 Amend subparagraph (b)(9): Start the gas flow measuring device, position the sample selector valves to direct the sample flow into the exhaust sample bag, the ~~methanol~~ alcohol exhaust sample, the formaldehyde exhaust sample, the dilution air sample bag, the ~~methanol~~ alcohol dilution air sample and the formaldehyde dilution air sample (turn on the petroleum-fueled diesel-cycle THC analyzer system integrator, mark the recorder chart, start particulate sample pump No. 1, and record both gas meter or flow measurement instrument readings, if applicable), and turn the key on. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be activated at the beginning of and operated throughout the UDDS.

6.3.2.2 Delete subparagraph (b)(13).

6.3.2.3 Amend subparagraph (b)(14): Turn the vehicle off 2 seconds after the end of the last deceleration (at 1,369 seconds).

6.3.2.4 Amend subparagraph (b)(15): Five seconds after the vehicle is shutdown, simultaneously turn off gas flow measuring device No. 1 and if applicable, turn off the hydrocarbon integrator No. 1, mark the hydrocarbon recorder chart, turn off the No. 1 particulate sample pump and close the valves isolating particulate filter No. 1, and position the sample selector valves to the “standby” position. Record the measured roll or shaft revolutions (both gas meter or flow measurement instrumentation readings), and reset the counter. As soon as possible, transfer the exhaust and dilution air samples to the analytical system and process the samples pursuant to §86.140, obtaining a stabilized reading of the exhaust bag sample on all analyzers within 20 minutes of the end of the sample

collection phase of the test. Obtain ~~methanol~~ alcohol and formaldehyde sample analyses, if applicable, within 24 hours of the end of the sample period. (If it is not possible to perform analysis on the ~~methanol~~ alcohol and formaldehyde samples within 24 hours, the samples should be stored in a dark cold (4°C to 10°C) environment until analysis. The samples should be analyzed within fourteen days.) If applicable, carefully remove both pairs of particulate sample filters from their respective holders, and place each in a separate petri dish, and cover.

6.3.~~32.5~~ Amend subparagraph (b)(18): Repeat the steps in paragraphs (b)(2) through (b)(17) of this section for the hot start test. The step in paragraph (b)(9) of this section shall begin between 9 and 11 minutes after the end of the sample period for the cold start test.

6.3.~~42.6~~ Delete subparagraph (b)(19).

6.3.~~52.7~~ Delete subparagraph (b)(20).

6.3.~~62.8~~ Amend subparagraph (b)(21): As soon as possible, and in no case longer than one hour after the end of the hot start phase of the test, transfer the four particulate filters to the weighing chamber for post-test conditioning, if applicable. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the UDDS, a valid test shall satisfy the SOC Criterion (see Definitions, section B of these procedures).

6.3.~~72.9~~ Amend subparagraph (b)(24): Vehicles to be tested for evaporative emissions will proceed pursuant to the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles.” ~~as incorporated by reference herein.~~

6.4 Calculations - Exhaust Emissions for All Hybrid Electric Vehicles, Except Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §86.144-94 [July 13, 2005] with the following revisions:

6.4.1 Amend subparagraph (a): For light-duty vehicles and light duty trucks:

$$Y_{wm} = 0.43 * \left(\frac{Y_c}{D_c} \right) + 0.57 * \left(\frac{Y_h}{D_h} \right)$$

Where:

(1) Y_{wm} = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, ~~NMHC~~ NMOG, NMHCE, CH₄, NO_x, or CO₂, in grams per vehicle mile.

- (2) Y_c = Mass emissions as calculated from the cold start test, in grams per test.
- (3) Y_h = Mass emissions as calculated from the hot start test, in grams per test.
- (4) D_c = The measured driving distance from the cold start test, in miles.
- (5) D_h = The measured driving distance from the hot start test, in miles.

6.4.2 Subparagraphs (b) through (e). [No change.]

6.5 Calculations - Particulate Emissions for All Hybrid Electric Vehicles, Except Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §86.145-82 [November 2, 1982] with the following revisions: References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

6.5.1 Amend subparagraph (a): The final reported test results for the mass particulate (M_p) in grams/mile shall be computed as follows:

$$M_p = 0.43 * \left(\frac{M_{pc}}{D_c} \right) + 0.57 * \left(\frac{M_{ph}}{D_h} \right)$$

Where:

- (1) M_{pc} = Mass of particulate determined from the cold start test, in grams per vehicle mile. (See §86.110-94 for determination.)
- (2) M_{ph} = Mass of particulate determined from the hot start test, in grams per vehicle mile. (See §86.110-94 for determination.)
- (3) D_c = The measured driving distance from the cold start test, in miles.
- (4) D_h = The measured driving distance from the hot start test, in miles.

6.5.2 Subparagraph (b). [No change.]

7. ~~Hybrid Electric Vehicle~~ Highway Emission Test Provisions for All Hybrid Electric Vehicles, Except Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §600.111-9308 [December 27, 2006] with the following revisions:

7.1 Subparagraph (a). [n/a]

7.1.2 Amend subparagraph (b) as follows:

7.2.1 Amend subparagraph (b)(2): The highway fuel economy test is designated to simulate non-metropolitan driving with an average speed of 48.6 mph and a maximum speed of 60 mph. The cycle is 10.2 miles long with 0.2 stop per mile and consists of warmed-up vehicle operation on a chassis dynamometer through a specified driving

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cycle. A proportional part of the diluted exhaust emission is collected continuously for subsequent analysis of THC, CO, CO₂, and NO_x using a constant volume (variable dilution) sampler. Diesel dilute exhaust is continuously analyzed for hydrocarbons using a heated sample line and analyzer. ~~Methanol~~ Alcohol and formaldehyde samples are collected and individually analyzed for ~~methanol~~ alcohol-fueled vehicles.

7.2.2 Amend subparagraph (b)(7)(i): The dynamometer procedure shall consist of two cycles of the Highway Fuel Economy Driving Schedule (§600.109(b)) separated by 15 seconds of idle. The first cycle of the Highway Fuel Economy Driving Schedule is driven to precondition the test vehicle and the second is driven for the fuel economy measurement.

7.2.3 Amend subparagraph ~~(f)(3)~~(b)(7)(iii): Only one exhaust sample and one background sample ~~are~~ shall be collected and analyzed for THC (except diesel hydrocarbons which are analyzed continuously), CO, CO₂, and NO_x. ~~Methanol~~ Alcohol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for ~~methanol~~ alcohol-fueled vehicles.

7.3.2.4 Add subparagraph ~~(f)(5)~~(b)(7)(v): ~~Battery state-of-charge shall be set prior to performing the HFEDS preconditioning cycle.~~ For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the HFEDS preconditioning cycle. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

- (i) If the hybrid electric vehicle is charge-sustaining over the HFEDS, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.
- (ii) If the hybrid electric vehicle is charge-depleting over the HFEDS, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions.

7.4.2.5 Amend subparagraph ~~(h)(5)~~(b)(9)(v): Operate the vehicle over one HFEDS preconditioning cycle according to the dynamometer driving schedule specified in §600.109-08(b) [December 27, 2006]. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the HFEDS preconditioning cycle.

7.5.2.6 Amend subparagraph ~~(h)(6)~~(b)(9)(vi): When the vehicle reaches zero speed at the end of the HFEDS preconditioning cycle, the driver has 17 seconds to prepare for the HFEDS emission measurement cycle of the test. Reset and enable the roll revolution counter. During the idle period, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the HFEDS, the vehicle shall be momentarily turned off for 5 seconds and turned back on during the idle period. The battery state-of-charge shall be recorded after the hybrid electric vehicle has fully turned on.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the HFEDS, the vehicle shall remain turned on during the idle period.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

7.6.2.7 Add subparagraph ~~(h)(9)~~(b)(9)(viii): At the conclusion of the HFEDS emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the HFEDS, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B.1 of these test procedures) is satisfied. If the SOC Criterion is not satisfied, then repeat dynamometer test run from subparagraph (h)(6). A total of three highway emission tests shall be allowed to satisfy the SOC Criterion. ~~Manufacturers may elect to repeat dynamometer test run from subparagraph (h)(6) if battery energy level increased significantly relative to the initial battery state of charge set at the beginning of the HFEDS emission test.~~

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the HFEDS, the emission test is completed.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the emission test is completed.

7.2.8 Delete subparagraph (b)(10).

7.3 Delete subparagraphs (c) through (e).

8. Hybrid Electric Vehicle SFTP Emission Test Provisions for All Hybrid Electric Vehicles, Except Off-Vehicle Charge Capable Hybrid Electric Vehicles.

8.1 US06 Vehicle Preconditioning

To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions:±

8.1.1 Subparagraphs (a) through (m). [No change.]

8.1.12 Amend subparagraph (n): Aggressive Driving Test (US06) Preconditioning.

8.1.2.1 Amend subparagraph (1) as follows: If the US06 test follows the exhaust emission FTP or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer ~~provided that battery state of charge has not been set; otherwise, if battery state of charge is set prior to securing vehicle on dynamometer, vehicle shall be pushed or towed into position on dynamometer. Battery state of charge shall be set prior to performing the US06 preconditioning cycle.~~ For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state of charge shall be set at a level that causes the ~~hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the US06 preconditioning drive.~~ For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

8.1.2.1.1 (i) Delete subparagraph (i), and replace with: If the hybrid electric vehicle is charge-sustaining over the US06, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

8.1.2.1.2 (ii) Delete subparagraph (ii), and replace with: If the hybrid electric vehicle is charge-depleting over the US06, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

~~8.1.2 Delete subparagraphs (n)(1)(i) and (n)(1)(ii).~~

8.1.2.1.3 Subparagraphs (iii) through (iv). [No change.]

8.1.2.2 Subparagraph (2). [No change.]

8.1.3 Subparagraph (o). [No change.]

8.2 US06 Emission Test.

To be conducted pursuant to 40 CFR §86.159-008 [December 27, 2006] with the following revisions: References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

8.2.1 Amend subparagraph (a): *Overview.* The dynamometer operation consists of a single, 600 second test on the US06 driving schedule, as described in appendix I, paragraph (g), of this part. The hybrid electric vehicle is preconditioned in accordance with §86.132-00, to bring it to a warmed-up stabilized condition. This preconditioning is followed by a 1 to 2 minute idle period that proceeds directly into the US06 driving schedule during which continuous proportional samples of gaseous emissions are collected for analysis. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For hybrid electric vehicles with ~~gasoline fueled~~ Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO₂, CH₄ and NO_x. For hybrid electric vehicles with ~~petroleum fueled~~ diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110-94. Parallel bag samples of dilution air are analyzed for THC, CO, CO₂, CH₄ and NO_x.

8.2.2 Amend subparagraph (b) as follows.

8.2.2.1 Amend subparagraph (b)(2): Position (~~vehicle shall be pushed or towed if battery state of charge is set prior to securing to dynamometer otherwise vehicle may be driven as well~~) the test vehicle on the dynamometer and restrain.

8.2.3 Subparagraph (c). [No change.]

8.2.3.4 Amend subparagraph (d): Practice runs over the prescribed driving schedule may be performed at test point, ~~provided that battery state of charge setting is conducted after practice and an emission sample is not taken, for the purpose of finding the appropriate throttle action to maintain the proper speed-time relationship, or to permit sampling system adjustment.~~

8.2.5 Subparagraph (e). [No change.]

8.2.4.6 Amend subparagraph (f) as follows.

8.2.6.1 Amend subparagraph (f)(2)(i): Immediately after completion of the US06 preconditioning cycle, idle the vehicle. The idle period is not to be less than one minute or not greater than two minutes. During the idle period, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the US06, the vehicle shall be momentarily turned off for 5 seconds and turned back on during the idle period. The battery state-of-charge shall be recorded after the hybrid electric vehicle has fully turned on.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the US06, the vehicle shall remain turned on during the idle period.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

8.2.56.2 Amend subparagraph (f)(2)(ix): At the conclusion of the US06 emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the US06, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B.1 of these test procedures) is satisfied. If the SOC Criterion is not satisfied, then repeat dynamometer test run from subparagraph (f)(2)(i). A total of three US06 emission tests shall be allowed to satisfy the SOC Criterion. ~~Manufacturers may elect to repeat dynamometer test run from subparagraph (f)(2)(i) if battery energy level increased significantly relative to the initial battery state-of-charge set at the beginning of US06 emission test.~~

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the US06, turn off vehicle 2 seconds after the end of the last deceleration.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, turn off vehicle 2 seconds after the end of the last deceleration.

8.3 SC03 Vehicle Preconditioning.

To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions:

8.3.1 Subparagraphs (a) through (n). [No change.]

8.3.12 Amend subparagraph (o): *Air Conditioning Test (SC03) Preconditioning.*

8.3.2.1 Amend subparagraph (1) as follows: If the SC03 test follows the exhaust emission FTP or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer, ~~provided that battery state-of-charge has not been set; otherwise, if battery state-of-charge is set prior to securing vehicle on dynamometer, vehicle shall be pushed or towed into position on dynamometer. Battery state-of-charge shall be set prior to performing the SC03 preconditioning cycle. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the SC03 preconditioning drive. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:~~

8.3.2.1.1 (i) Delete subparagraph (i), and replace with: If the hybrid electric vehicle is charge-sustaining over the SC03, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 preconditioning cycle.

8.3.2.1.2 (ii) Delete subparagraph (ii), and replace with: If the hybrid electric vehicle is charge-depleting over the SC03, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 preconditioning cycle.

~~8.3.2 Delete subparagraphs (o)(1)(i) and (o)(1)(ii).~~

8.3.2.2 Subparagraphs (2) through (3). [No change.]

8.4 SC03 Emission Test.

To be conducted pursuant to 40 CFR §86.160-00 [December 8, 2005] with the following revisions: References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

8.4.1 Amend subparagraph (a): *Overview.* The dynamometer operation consists of a single, 594 second test on the SC03 driving schedule, as described in appendix I, paragraph (h), of this part. The hybrid electric vehicle is preconditioned in accordance with §86.132-00 of this subpart, to bring the vehicle to a warmed-up stabilized condition. This preconditioning is followed by a 10 minute vehicle soak (vehicle turned off) that proceeds directly into the SC03 driving schedule, during which continuous proportional samples of gaseous emissions are collected for analysis. The

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entire test, including the SC03 preconditioning cycle, vehicle soak, and SC03 emission test, is either conducted in an environmental test facility or under test conditions that simulates testing in an environmental test cell (see ~~See~~ §86.162-00 (a) for a discussion of simulation procedure approvals). The environmental test facility must be capable of providing the following nominal ambient test conditions of: 95°F air temperature, 100 grains of water/pound of dry air (approximately 40 percent relative humidity), a solar heat load intensity of 850 W/m², and vehicle cooling air flow proportional to vehicle speed. Section 86.161-00 discusses the minimum facility requirements and corresponding control tolerances for air conditioning ambient test conditions. The vehicle's air conditioner is operated or appropriately simulated for the duration of the test procedure (except for the 10 minute vehicle soak), including the preconditioning. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For hybrid electric vehicles with ~~gasoline~~-fueled Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO₂, CH₄ and NO_x. For hybrid electric vehicles with ~~petroleum~~-fueled diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110-94. Parallel bag samples of dilution air are analyzed for THC, CO, CO₂, CH₄ and NO_x.

8.4.2 Amend subparagraph (b) as follows.

8.4.2.1 Amend subparagraph (b)(2): Position ~~(vehicle shall be pushed or towed if battery state of charge is set prior to securing to dynamometer otherwise vehicle may be driven as well)~~ the test vehicle on the dynamometer and restrain.

8.4.3 Amend subparagraph (c) as follows.

8.4.3.1 Amend subparagraph (c)(9): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the hybrid electric vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 emission test. Fifteen seconds after the vehicle starts, begin the initial vehicle acceleration of the driving schedule.

~~8.4.4 Amend subparagraph (c)(12): Turn the vehicle off 2 seconds after the end of the last deceleration.~~

~~8.4.5 Amend subparagraph (d)(7): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the hybrid electric vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 emission test. Fifteen seconds after the vehicle starts, begin the initial vehicle acceleration of the driving schedule.~~

8.4.4 Amend subparagraph (d) as follows.

8.4.64.1 Amend subparagraph (d)(10): At the conclusion of the ~~US06~~ SC03 emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the SC03, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B.1 of these procedures) is satisfied. If the SOC Criterion is not satisfied, then turn off cooling fan(s), allow vehicle to soak in the ambient conditions of paragraph (c)(5) of this section for 10 minutes, and repeat dynamometer test run from subparagraph (d). A total of three SC03 emission tests shall be attempted to satisfy the SOC Criterion. ~~Manufacturers may elect to repeat dynamometer test run from subparagraph (d) following a 10 minute soak in the ambient conditions of paragraph (c)(5) of this section if battery energy level increased significantly relative to the initial battery state of charge set at the beginning of SC03 emission test.~~

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the SC03, turn off vehicle 2 seconds after the end of the last deceleration.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, turn off vehicle 2 seconds after the end of the last deceleration.

8.4.5 Subparagraph (e). [No change.]

9. State-of-Charge Net Change Tolerances for All Hybrid Electric Vehicles, Except Off-Vehicle Capable Hybrid Electric Vehicles.

9.1 For hybrid electric vehicles that use a battery as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(\text{Amp-hr}_{\text{final}})_{\text{max}} = (\text{Amp-hr}_{\text{initial}}) + 0.01 * \left(\frac{NHV_{\text{fuel}} * m_{\text{fuel}}}{V_{\text{system}} * K_1} \right)$$

$$(\text{Amp-hr}_{\text{final}})_{\text{min}} = (\text{Amp-hr}_{\text{initial}}) - 0.01 * \left(\frac{NHV_{\text{fuel}} * m_{\text{fuel}}}{V_{\text{system}} * K_1} \right)$$

Where:

- (Amp-hr_{final})_{max} = Maximum allowed Amp-hr stored in battery at the end of the test
- (Amp-hr_{final})_{min} = Minimum allowed Amp-hr stored in battery at the end of the test
- (Amp-hr_{initial}) = Battery Amp-hr stored at the beginning of the test
- NHV_{fuel} = Net heating value of consumable fuel, in Joules/kg

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- m_{fuel} = Total mass of fuel consumed during test, in kg
- K_1 = Conversion factor, 3600 seconds/hour
- V_{system} = Average charge sustaining B battery DC bus voltage (open circuit) during charge sustaining operation. This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board.

9.2 For hybrid electric vehicles that use a capacitor as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(V_{final})_{max} = \sqrt{V_{initial}^2 + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{C}}$$

$$(V_{final})_{min} = \sqrt{V_{initial}^2 - 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{C}}$$

Where:

- $(V_{final})_{max}$ = The stored capacitor voltage allowed at the end of the test
- $(V_{final})_{min}$ = The stored capacitor voltage allowed at the end of the test
- $V_{initial}^2$ = The square of the capacitor voltage stored at the beginning of the test
- NHV_{fuel} = Net heating value of consumable fuel, in Joules/kg
- m_{fuel} = Total mass of fuel consumed during test, in kg
- C = Rated capacitance of the capacitor, in Farads

9.3 For hybrid electric vehicles that use an electro-mechanical flywheel as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(rpm_{final})_{max} = \sqrt{rpm_{initial}^2 + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{I * K_3}}$$

$$(rpm_{final})_{min} = \sqrt{rpm_{initial}^2 - 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{I * K_3}}$$

Where:

- $(rpm_{final})_{max}$ = The maximum flywheel rotational speed allowed at the end of the test
- $(rpm_{final})_{min}$ = The minimum flywheel rotational speed allowed at the end of the test
- $rpm_{initial}^2$ = The squared flywheel rotational speed at the beginning of the test
- NHV_{fuel} = Net heating value of consumable fuel, in Joules/kg
- m_{fuel} = Total mass of fuel consumed during test, in kg

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$$K_3 = \text{Conversion factor, } \frac{4\pi^2}{3600 \text{ sec}^2 - \text{rpm}^2}$$

$$I = \text{Rated moment of inertia of the flywheel, in kg-m}^2$$

F. Test Procedures for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

The “as adopted or amended dates” of the 40 CFR Part 86 regulations referenced by this document are the dates identified in the “California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles,” unless otherwise noted.

1. Electric Dynamometer. All off-vehicle charge capable HEVs must be tested using a 48-inch single roll electric dynamometer meeting the requirements of 40 CFR Subpart B, §86.108-00(b)(2) [October 22, 1996].

2. Vehicle and Battery Break-In Period. A manufacturer shall use good engineering judgment in determining the proper stabilized emissions mileage test point and report same according to the requirements of section D.2.11 above.

3. General Testing Requirements.

3.1 Recording requirements.

For off-vehicle charge capable hybrid electric vehicles: The following data shall be recorded for all charge depleting range and exhaust tests and for each individual test cycle therein:

(a) mileage accumulated during the All-Electric Range portion of the test, where applicable;

(b) Net DC energy from the battery that was expended during the test (may be reported as the total DC battery energy output and the total DC battery energy input);

(c) AC energy required to fully charge the battery after a charge depleting or charge sustaining test from the point where electricity is introduced from the electric outlet to the battery charger;

(d) DC energy required to fully charge the battery after a charge depleting or charge sustaining test from the point where electricity is introduced from the battery charger to the battery; and

(e) Net DC amp-hrs from the battery that was expended during the test (may be reported as the total DC amp-hrs output and the total DC amp-hrs input)

3.2 Regenerative braking. Regenerative braking systems may be utilized during the range test. The braking level, if adjustable, shall be set according to the manufacturer’s specifications prior to the commencement of the test. The driving schedule speed and time tolerances specified in F.3.1 or F.3.2 shall not be exceeded due to the operation of the regenerative braking system.

3.3 Measurement Accuracy. The overall error in voltage and current recording instruments shall not exceed 1% of the maximum value of the variable being measured. Suggested equipment: clamp-on amp meter/power meter capable of sampling voltage and current. Voltage and current shall be sampled at a minimum rate of 20 hz.

3.4 Watt Hour Calculation.

DC energy (watt hours) shall be calculated as follows

$$\text{DC energy} = \int v(t) * i(t) dt$$

Where v = vehicle DC main battery pack voltage

i = vehicle DC main battery pack current

4. Determination of the Emissions of the Fuel-fired Heater.

The exhaust emissions result of the fuel-fired heater shall be determined by operating at a maximum heating capacity with a cold start between 68°F and 86°F for a period of 20 minutes and dividing the grams of emissions by 20. The resulting grams per minute shall be multiplied by 3.0 minutes per mile to obtain a grams per mile value.

5. Urban Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

Alternative procedures may be used if shown to yield equivalent results and if approved in advance by the Executive Officer of the Air Resources Board. The criteria certification emissions for the Urban test shall be the worst case emissions of NMOG, CO, NOx, and PM from either the charge depleting or charge sustaining tests. The sum of NMOG + NOx emissions shall constitute the worst case for the charge sustaining or charge depleting modes of operation.

Vehicles with more than one mode of operation for a given charge depleting or charge sustaining test cycle must be tested in the mode(s) which represents maximum operation of the auxiliary power unit. Confirmatory testing may also be performed in any mode of operation to ensure compliance with emission standards.

5.1 Vehicle Preconditioning.

To be conducted pursuant to the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles” with the following supplemental requirements:

5.1.1 For vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the preconditioning drive.

5.1.2 For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

5.1.3 After setting battery state-of-charge, the vehicle shall be pushed or towed to a work area for the initial fuel drain and fill according to section III.D.1.4 of the “California

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Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles.”

5.1.4 Following the initial fuel drain and fill, the vehicle shall complete an initial soak period of a minimum of 6 hours. After completing the soak period, the vehicle shall be pushed or towed into position on a dynamometer and preconditioned. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the preconditioning drive.

5.2 Urban Dynamometer Procedure for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §86.135-00 [October 22, 1996] with the following revisions. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

5.2.1 Amend subparagraph (a).

Overview. The dynamometer run shall consist of a series of charge depleting tests, after a second fuel drain and fill and a 12 to 36 hour soak period performed pursuant to the provisions of the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles.” Each charge depleting test shall consist of one UDDS test followed by a 10 minute hot soak period until charge sustaining operation is achieved for a pair of UDDS tests. Once charge sustaining operation is achieved over two consecutive UDDS tests, the vehicle shall be turned off and stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. If the energy required to charge the vehicle from urban charge sustaining operation to full charge is not equivalent (within ± 1% of the AC energy) to the energy required to charge the vehicle from highway charge sustaining operation to full charge, the vehicle must be recharged. If the energy required to charge the vehicle from urban charge sustaining operation to full charge is equivalent (within ± 1% of the AC energy) to the energy required to charge the vehicle from highway charge sustaining operation to full charge, the vehicle may be recharged. The vehicle must be turned off during recharging. At the end of this cold soak period, the vehicle shall be placed or pushed onto a dynamometer. Vehicle emissions shall be measured over two UDDS cycles during charge sustaining operation, each separated by a 10 minute key off hot soak period. The vehicle must meet SOC criteria (section F.10) from the start of the first test until the end of the second test.

For all exhaust emission tests, the exhaust emissions are diluted with ambient air in the dilution tunnel as shown in Figure B94-5 and Figure B94-6 (§86.110-94). A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. For UDDS tests, particulate samples are collected on filters for weighing during each test. Each sample plus backup is collected during each UDDS test (including shutdown). Continuous proportional samples of gaseous emissions are collected for analysis during each test. For vehicles with Otto-cycle auxiliary power

units, the composite samples collected in bags are analyzed for THC, CO, CO₂, CH₄ and NO_x. For vehicles with petroleum-fueled diesel-cycle auxiliary power units (optional for natural gas-fueled, liquefied petroleum gas-fueled, and alcohol-fueled diesel-cycle vehicles), THC is sampled and analyzed continuously pursuant to the provisions of §86.110-94. Parallel samples of the dilution air are similarly analyzed for THC, CO, CO₂, CH₄ and NO_x. For vehicles with natural gas-fueled, liquefied petroleum gas-fueled, and alcohol-fueled auxiliary power units, bag samples are collected and analyzed for THC (if not sampled continuously), CO, CO₂, CH₄ and NO_x. For vehicles with alcohol-fueled auxiliary power units, alcohol and formaldehyde samples are taken for both exhaust emissions and dilution air (a single dilution air formaldehyde sample, covering the total test period may be collected). Parallel bag samples of dilution air are analyzed for THC, CO, CO₂, CH₄ and NO_x.

5.2.2 Subparagraphs (b) through (c). [No change.]

5.2.3 Delete subparagraph (d).

5.2.4 Subparagraphs (e) through (g). [No change.]

5.2.5 Amend subparagraph (h): The driving distance, as measured by counting the number of dynamometer roll or shaft revolutions, shall be determined for all charge depleting and exhaust emission tests. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.

5.2.6 Subparagraph (i). [No change.]

5.3 Urban Dynamometer Test Run, Gaseous and Particulate Emissions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §86.137-96 [March 24, 1993] with the following revisions:

5.3.1 Amend subparagraph (a): *General.* The dynamometer run shall consist of a series of UDDS tests, after a second fuel drain and fill and a 12 to 36 hour soak period performed pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles." The vehicle shall be stored prior to the emission test in such a manner that precipitation (e.g., rain or dew) does not occur on the vehicle. The vehicle is allowed to stand on the dynamometer during the 10 minute time period between each UDDS test.

5.3.2 Amend subparagraph (b) as follows.

5.3.2.1 Amend subparagraph (b)(9): Start the gas flow measuring device, direct the sample flow into the exhaust sample bag, the alcohol exhaust sample, the formaldehyde exhaust sample, the dilution air sample bag, the alcohol dilution air sample and the formaldehyde dilution air sample, and turn the key on.

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If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be activated at the beginning of and operated throughout the UDDS.

5.3.2.2 Delete subparagraph (b)(13).

5.3.2.3 Subparagraph (b)(14). [No change.]

5.3.2.4 Amend subparagraph (b)(15): Five seconds after the vehicle is shutdown, simultaneously turn off the gas flow measuring device and particulate sample pump. Record the measured roll or shaft revolutions (both gas meter or flow measurement instrumentation readings), and reset the counter. As soon as possible, transfer the exhaust and dilution air samples to the analytical system and process the samples pursuant to §86.140, obtaining a stabilized reading of the exhaust bag sample on all analyzers within 20 minutes of the end of the sample collection phase of the test. Obtain alcohol and formaldehyde sample analyses, if applicable, within 24 hours of the end of the sample period. (If it is not possible to perform analysis on the alcohol and formaldehyde samples within 24 hours, the samples should be stored in a dark cold (4°C to 10°C) environment until analysis. The samples should be analyzed within fourteen days.) If applicable, carefully remove both pairs of particulate sample filters from their respective holders, and place each in a separate petri dish, and cover.

5.3.2.5 Amend subparagraph (b)(18): Repeat the steps in paragraphs (b)(2) through (b)(17) of this section for the hot start test. The step in paragraph (b)(9) of this section shall begin between 9 and 11 minutes after the end of the sample period for the cold start test.

5.3.2.6 Delete subparagraph (b)(19).

5.3.2.7 Delete subparagraph (b)(20).

5.3.2.8 Amend subparagraph (b)(21): As soon as possible, transfer the particulate filters to the weighing chamber for post-test conditioning, if applicable. For vehicles undergoing a cold start charge sustaining test, a valid test shall satisfy the SOC Criterion (see Definitions, section B.1 of these procedures).

5.3.2.9 Amend subparagraph (b)(24): Vehicles to be tested for evaporative emissions will proceed pursuant to the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles.”

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5.4 Determination of Urban All-Electric Range and Urban Equivalent All-Electric Range for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

5.4.1 The Urban All-Electric Range shall be defined as the distance that the vehicle is driven from the start of Urban Charge Depleting Range Test until the internal combustion engine first starts.

5.4.2 Cold soak and vehicle charging. The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state of charge. The vehicle must be turned off during charging. Charge time shall not exceed soak time.

5.4.3 Urban Charge Depleting Range Test. At the end of the cold soak period, the vehicle shall be placed or pushed, onto a dynamometer and operated through the Continuous Urban Test Schedule until the State-of-Charge Net Change Tolerances (specified in section F.10 of these test procedures) that indicate charge sustaining operation are met for two consecutive UDDS tests. The Alternative Continuous Urban Test Schedule may be substituted for the Continuous Urban Test Schedule if the test facility is unable to perform the Continuous Urban Test Schedule. Refer to sections F.5.5, F.5.6, and F.11, for calculations of urban exhaust emissions, urban particulate emissions, and equivalent all-electric range, respectively.

5.4.4 Urban Charge Sustaining Emission Test. The Urban Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed.

(i) Cold soak: The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours.

(ii) At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer, and two UDDS cycles shall be performed during charge sustaining operation, each separated by a 10 minute key off hot soak period. The vehicle must meet SOC criteria (section F.10) from the start of the first test until the end of the second test. If the SOC Criterion is not satisfied, the test shall be stopped, the vehicle cold soak shall be conducted again, and the dynamometer test run shall be conducted again.

5.5 Calculations - Urban Exhaust Emissions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §86.144-94 [July 13, 2005] with the following revisions:

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5.5.1 Amend subparagraph (a):

Gaseous Emissions – Urban Charge Depleting Range Test.

For light-duty vehicles and light duty trucks:

$$\underline{Y_{wm}} = 0.43 * \left(\frac{Y_c}{D_c} \right) + 0.57 * \left(\frac{\Sigma Y_n}{\Sigma D_n} \right)$$

Where:

(1) Y_{wm} = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMOG, NMHCE, CH₄, NO_x, or CO₂, in grams per vehicle mile.

(2) Y_c = Mass emissions as calculated from the cold start test, in grams per test.

(3) D_c = The measured driving distance from the cold start test, in miles.

(4) n = number of hot start UDDS tests in Charge Depleting operation

Gaseous Emissions – Urban Charge Sustaining Emission Test.

For light-duty vehicles and light-duty trucks:

$$\underline{Y_{wm}} = 0.43 * \left(\frac{Y_c}{D_c} \right) + 0.57 * \left(\frac{Y_h}{D_h} \right)$$

Where:

(1) Y_{wm} = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMOG, NMHCE, CH₄, NO_x, or CO₂, in grams per vehicle mile.

(2) Y_c = Mass emissions as calculated from the cold start test, in grams per test.

(3) Y_h = Mass emissions as calculated from the hot start test, in grams per test.

(4) D_c = The measured driving distance from the cold start test, in miles.

(5) D_h = The measured driving distance from the hot start test, in miles.

5.5.2 Subparagraphs (b) through (e). [No change.]

5.6 Calculations - Urban Particulate Emissions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §86.145-82 [November 2, 1982] with the following revisions. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

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5.6.1 Amend subparagraph (a):

Particulate Emissions – Urban Charge Depleting Range Test.

The final reported test results for the mass particulate (M_p) in grams/mile shall be computed as follows:

$$M_p = 0.43 * \left(\frac{M_{pc}}{D_c} \right) + 0.57 * \left(\frac{\Sigma M_{pn}}{\Sigma D_n} \right)$$

Where:

(1) M_{pc} = Mass of particulate determined from the cold start test, in grams per vehicle mile. (See §86.110-94 for determination.)

(2) D_c = The measured driving distance from the cold start test, in miles.

(3) n = number of hot start UDDS tests in Charge Depleting operation

Particulate Emissions – Urban Charge Sustaining Emission Test.

The final reported test results for the mass particulate (M_p) in grams/mile shall be computed as follows:

$$M_p = 0.43 * \left(\frac{M_{pc}}{D_c} \right) + 0.57 * \left(\frac{M_{ph}}{D_h} \right)$$

Where:

(1) M_{pc} = Mass of particulate determined from the cold start test, in grams per vehicle mile. (See §86.110-94 for determination.)

(2) M_{ph} = Mass of particulate determined from the hot start test, in grams per vehicle mile. (See §86.110-94 for determination.)

(3) D_c = The measured driving distance from the cold start test, in miles.

(4) D_h = The measured driving distance from the hot start test, in miles.

5.6.2 Subparagraph (b). [No change.]

5.6.3 **Equivalent All-Electric Range** shall be calculated in accordance with section F.11 of these test procedures.

6. Highway Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

The third HFEDS cycle of the Highway Charge Sustaining Test shall be used to calculate emissions and must be within the state-of-charge net tolerances as calculated in section F.10.

Vehicles with more than one mode of operation for a given charge depleting or charge sustaining test cycle must be tested in the mode(s) which represents maximum operation of the

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auxiliary power unit. Confirmatory testing may also be performed in any mode of operation to ensure compliance with emission standards.

6.1 Vehicle Preconditioning.

If the Highway Charge Depleting Range Test is performed within 36 hours after completion of either the Urban Charge Depleting Range Test or the Urban Charge Sustaining Range Test, no preconditioning is necessary. If the Highway Charge Depleting Range Test is performed more than 36 hours after completion of either the Urban Charge Depleting Range Test or the Urban Charge Sustaining Range Test, the manufacturer shall precondition the vehicle pursuant to section F.5.1 of these test procedures, without loading the evaporative canister.

6.2 Highway Dynamometer Procedure for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §600.111-08 [December 27, 2006] with the following revisions. This section F.6.1 shall apply during both charge sustaining and charge depleting operation.

6.2.1 Subparagraph (a). [n/a]

6.2.2 Amend subparagraph (b) as follows:

6.2.2.1 Amend subparagraph (b)(2): The highway fuel economy test is designated to simulate non-metropolitan driving with an average speed of 48.6 mph and a maximum speed of 60 mph. The cycle is 10.2 miles long with 0.2 stop per mile and consists of warmed-up vehicle operation on a chassis dynamometer through a specified driving cycle. A proportional part of the diluted exhaust emission is collected continuously for subsequent analysis of THC, CO, CO₂, and NO_x using a constant volume (variable dilution) sampler. Diesel dilute exhaust is continuously analyzed for hydrocarbons using a heated sample line and analyzer. Alcohol and formaldehyde samples are collected and individually analyzed for alcohol-fueled vehicles.

6.2.2.2 Replace subparagraph (b)(6) with: Cold soak: The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state of charge. Charge time shall not exceed the soak time. At the end of the cold soak period, the vehicle shall be placed, either driven or pushed onto a dynamometer.

6.2.2.3 Amend subparagraph (b)(7)(i):

(a) The Highway Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed.

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Cold soak: The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours.

At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer

The three HFEDS cycles of each separated by a 15 second key on hot soak period shall be performed. The vehicle must meet SOC criteria (section F.10) individually for all three tests. If the SOC Criterion is not satisfied, the test shall be stopped, the vehicle cold soak shall be conducted again, and the dynamometer test run shall be conducted again.

6.2.2.4 Amend subparagraph (b)(7)(iii): One exhaust sample and one background sample per each HFEDs shall be collected and analyzed for THC (except diesel hydrocarbons which are analyzed continuously), CO, CO₂, and NO_x. Alcohol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for alcohol-fueled vehicles.

6.2.2.5 Add subparagraph (b)(7)(v): For vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the HFEDS preconditioning cycle. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

6.2.2.6 Amend subparagraph (b)(9)(v): Operate the vehicle over the continuous highway test schedule, consisting of repeated HFEDS cycles according to the dynamometer driving schedule specified in §600.109-08(b) [December 27, 2006]. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the HFEDS preconditioning cycle.

6.2.2.7 Amend subparagraph (b)(9)(vi): When the vehicle reaches zero speed between each HFEDS cycle, the driver has 17 seconds to prepare for the HFEDS emission measurement cycle of the test. During the idle period, one of the following conditions shall apply:

(i) For vehicles that do not allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on during the idle period.

(ii) For vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

6.2.2.8 Add subparagraph (b)(9)(viii): At the conclusion of the HFEDS emission test, the following conditions shall apply: For vehicles that do not allow the auxiliary

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power unit to be manually activated and are charge-sustaining over the HFEDS, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B.1 of these test procedures) is satisfied. If the SOC Criterion is not satisfied, then repeat dynamometer test run from subparagraph (h)(6). A total of two highway emission tests shall be allowed to satisfy the SOC Criterion.

6.2.2.9 Delete subparagraph (b)(10).

6.2.3 Delete subparagraphs (c) through (e).

6.3 Determination of Highway All-Electric Range and Highway Equivalent All-Electric Range for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

6.3.1 The **Highway All-Electric Range** shall be defined as the distance that the vehicle is driven from the start of test until the internal combustion engine starts.

6.3.2 **Cold soak and vehicle charging.** The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state-of-charge. Charge time shall not exceed soak time.

6.3.3 **Highway Charge Depleting Range Test.** At the end of the cold soak period, the vehicle shall be placed or pushed, onto a dynamometer and operated through the Continuous Highway Test Schedule until the State-of-Charge Net Change Tolerances (specified in section F.10 of these test procedures) that indicate charge sustaining operation is met for two consecutive UDDS tests. The Alternative Continuous Highway Test Schedule may be substituted for the Continuous Highway Test Schedule if the test facility is unable to perform the Continuous Highway Test Schedule. Refer to sections F.6.3.4, and F.11, for calculations of highway exhaust emissions and equivalent all-electric range, respectively.

If the energy required to charge the vehicle from highway charge sustaining operation to full charge is not equivalent (within $\pm 1\%$ of the AC energy) to the energy required to charge the vehicle from urban charge sustaining operation to full charge, repeat subparagraphs F.6.2.2 and F.6.2.3. Battery charging in F.6.3.2 shall begin within one hour of the end of the Highway Charge Depleting Range Test.

6.3.4 **Highway Charge Sustaining Emission Test.** The Highway Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed:

(i) **Cold soak:** The vehicle shall be stored at an ambient temperature not less than 68°F (20°C) and not more than 86°F (30°C) for 12 to 36 hours.

(ii) At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer, and three HFEDS cycles of each separated by a 15 second key on hot

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soak period shall be performed. The vehicle must meet SOC criteria (section F.10) individually for all three tests. If the SOC Criterion is not satisfied, the test shall be stopped, the vehicle cold soak shall be conducted again, and the dynamometer test run shall be conducted again.

6.3.5 Equivalent All-Electric Range shall be calculated in accordance with section F.11 of these test procedures.

7. SFTP Emission Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

Hybrid electric vehicles with more than one mode of operation for a given charge depleting or charge sustaining test cycle must be tested in the mode(s) which represents maximum operation of the auxiliary power unit. Confirmatory testing may also be performed in any mode of operation to ensure compliance with emission standards.

7.1 US06 Vehicle Preconditioning.

To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions. This section 7.1 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed.

7.1.1 Subparagraphs (a) through (m). [No change.]

7.1.2 Amend subparagraph (n) *Aggressive Driving Test (US06) Preconditioning*. as follows:

7.1.2.1 Amend subparagraph (1) as follows: If the US06 test follows the exhaust emission urban, highway, or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

7.1.2.1.1 Delete subparagraphs (i) and (ii).

7.1.2.1.2 Subparagraphs (iii) through (iv). [No change.]

7.1.2.2 Subparagraph (2). [No change.]

7.1.3 Subparagraph (o). [No change.]

7.2 US06 Emission Test.

To be conducted pursuant to 40 CFR §86.159-08 [December 27, 2006] with the following revisions. This section 7.2 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

7.2.1 Amend subparagraph (a): Overview. The dynamometer operation consists of a single, 600 second test on the US06 driving schedule, as described in appendix I, paragraph (g), of this part. The vehicle is preconditioned in accordance with §86.132-00, to bring it to a warmed-up stabilized condition. This preconditioning is followed by a 1 to 2 minute idle period that proceeds directly into the US06 driving schedule during which continuous proportional samples of gaseous emissions are collected for analysis. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO₂, CH₄ and NO_x. For vehicles with diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110-94. Parallel bag samples of dilution air are analyzed for THC, CO, CO₂, CH₄ and NO_x. The second US06 cycle (the cycle after preconditioning) shall be used to calculate emissions and shall be within the state-of-charge net tolerances as calculated in section F.10.

7.2.2 Amend subparagraph (b) as follows.

7.2.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.

7.2.3 Subparagraph (c). [No change.]

7.2.4 Amend subparagraph (d): Practice runs over the prescribed driving schedule may be performed at test point to permit sampling system adjustment.

7.2.5 Subparagraph (e). [No change.]

7.2.6 Amend subparagraph (f) as follows.

7.2.6.1 Amend subparagraph (f)(2)(i): Immediately after completion of the US06 preconditioning cycle, idle the vehicle. The idle period is not to be less than one minute or not greater than two minutes. During the idle period, one of the following conditions shall apply:

(i) For vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the US06, the vehicle shall remain on during the idle period. The battery state-of-charge shall be recorded after the vehicle has started idle.

(ii) For vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

7.2.6.2 Amend subparagraph (f)(2)(ix): For vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the US06, determine if the SOC Criterion (see Definitions, section B.1 of these test procedures) is satisfied at the end of the US06 emission test. If the SOC Criterion is not satisfied, then repeat dynamometer test run from subparagraph (f)(2)(i). A total of two US06 emission tests shall be allowed to satisfy the SOC Criterion.

7.3 SC03 Vehicle Preconditioning.

To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions. This section 7.3 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed.

7.3.1 Subparagraphs (a) through (n). [No change.]

7.3.2 Amend subparagraph (o): *Air Conditioning Test (SC03) Preconditioning.*

7.3.2.1 Amend subparagraph (1) as follows: If the SC03 test follows the exhaust emission urban, highway, or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 preconditioning cycle.

7.3.2.1.1 Delete subparagraphs (i) and (ii).

7.3.2.2 Subparagraphs (2) through (3). [No change.]

7.4 SC03 Emission Test.

To be conducted pursuant to 40 CFR §86.160-00 [December 8, 2005] with the following revisions. This section 7.4 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.

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7.4.1 Amend subparagraph (a): Overview. The dynamometer operation consists of a single, 594 second test on the SC03 driving schedule, as described in appendix I, paragraph (h), of this part. The vehicle is preconditioned in accordance with §86.132-00 of this subpart, to bring the vehicle to a warmed-up stabilized condition. This preconditioning is followed by a 10 minute vehicle soak (vehicle turned off) that proceeds directly into the SC03 driving schedule, during which continuous proportional samples of gaseous emissions are collected for analysis. The entire test, including the SC03 preconditioning cycle, vehicle soak, and SC03 emission test, is either conducted in an environmental test facility or under test conditions that simulates testing in an environmental test cell (see §86.162-00 (a) for a discussion of simulation procedure approvals). The environmental test facility must be capable of providing the following nominal ambient test conditions of: 95°F air temperature, 100 grains of water/pound of dry air (approximately 40 percent relative humidity), a solar heat load intensity of 850 W/m², and vehicle cooling air flow proportional to vehicle speed. Section 86.161-00 discusses the minimum facility requirements and corresponding control tolerances for air conditioning ambient test conditions. The vehicle's air conditioner is operated or appropriately simulated for the duration of the test procedure (except for the 10 minute vehicle soak), including the preconditioning. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO₂, CH₄ and NO_x. For vehicles with diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110-94. Parallel bag samples of dilution air are analyzed for THC, CO, CO₂, CH₄ and NO_x. The second SC03 cycle (the cycle after preconditioning) shall be used to calculate emissions and shall be within the state-of-charge net tolerances as calculated in section F.10.

7.4.2 Amend subparagraph (b) as follows.

7.4.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.

7.4.3 Amend subparagraph (c) as follows.

7.4.3.1 Amend subparagraph (c)(8): Add the following: Immediately after completion of the SC03 preconditioning cycle, idle the vehicle. The idle period shall not be less than one minute and not greater than two minutes. During the idle period, one of the following conditions shall apply:

(i) For vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the SC03, the vehicle shall remain on during the idle period. The battery state-of-charge shall be recorded after the vehicle has started idle.

(ii) For vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

7.4.3.2 Amend subparagraph (c)(9): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 emission test. Fifteen seconds after the vehicle starts, begin the initial vehicle acceleration of the driving schedule.

7.4.4 Amend subparagraph (d) as follows.

7.4.4.1 Amend subparagraph (d)(10): For vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the SC03, determine if the SOC Criterion (see Definitions, section B.1 of these procedures) is satisfied at the end of the SC03 emission test. If the SOC Criterion is not satisfied, then turn off cooling fan(s), allow vehicle to soak in the ambient conditions of paragraph (c)(5) of this section for 10 minutes, and repeat dynamometer test run from subparagraph (d). A total of two SC03 emission tests shall be attempted to satisfy the SOC Criterion.

7.4.5 Subparagraph (e). [No change.]

8. 50°F and 20°F Test Provision for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

8.1 To satisfy test requirements for the 50°F emission test, the vehicle shall be tested in the worst case (NMHC + NO_x) of the urban charge sustaining range test or urban charge sustaining test as defined in section F.5. To satisfy test requirements for the 20°F emission test, the vehicle shall be tested in the worst case (CO) of the urban charge sustaining range test or urban charge sustaining test as defined in section F.5.

8.2 For emission purposes, a three phase emission test may be used with the following requirements:

(i) If urban charge sustaining emission test is required, the vehicle shall be preconditioned according to section F.5.1.

(ii) If the urban charge depleting range test is required, the vehicle shall be preconditioned according to section F.5.1 and fully charged. The continuous urban test schedule shall be performed. However, the first two phase of the three phase test shall be first counted as the first UDDS whenever the auxiliary power unit starts for the first time and the third phase will consist of the standard 505 second test.

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(iii) The vehicle is not required to meet SOC net tolerances for the 20°F test, the 50°F test, the charge sustaining emission test, or the urban charge depleting range test.

9. Additional Provisions.

9.1 Confirmatory testing may be performed on all tests to establish if higher emissions occur at different states of charge in charge depleting mode. This is to ensure that cold start and other emissions standards are not exceeded at other operating SOCs.

9.2 Confirmatory testing may be performed on the US06 test or the manufacturer may provide data to show that potential cold start off-cycle emissions are controlled to the extent that they are controlled for the UDDS test.

9.3 Confirmatory testing may be performed on vehicles equipped with an optional charge sustaining operation mode selector with selector set to simulate charge sustaining operation or in actual charge sustaining operation in accordance with section F of these test procedures.

9.4 If data can be provided to show that the AC energy required to fully charge the vehicle in three hours following an urban or highway charge depleting range test is within ± 1% of the AC energy required to fully charge the vehicle within one hour following the urban or highway charge depleting range test, then a period of up to three hours may be used to initiate charge on the vehicle after either the urban or highway charge depleting range tests are completed.

9.5 If data can be provided to show that the AC energy required to fully charge the vehicle following the urban charge depleting range test is greater than the AC energy required to recharge the vehicle after the highway charge depleting range test, then the measured AC energy required to recharge the vehicle following the urban charge depleting range test may be used to calculate the Highway Equivalent All-Electric Range Energy Consumption, in section F.11.7.

9.6 For an example of an off-vehicle charge capable hybrid electric vehicle with all-electric range and blended operation that has charge depleting actual range and charge depleting cycle range, please see section H, Figure 1.

9.7 For an example of charge depleting to charge sustaining range with and without transitional range and end of test conditions, please see section H, Figure 2.

10. State-of-Charge Net Change Tolerances.

10.1 For vehicles that use a battery as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$\underline{(\text{Amp-hr}_{\text{final}})_{\text{max}} = (\text{Amp-hr}_{\text{initial}}) + 0.01 * \left(\frac{NHV_{\text{fuel}} * m_{\text{fuel}}}{V_{\text{system}} * K_1} \right)}$$

$$\underline{(Amp-hr_{final})_{min}} = \underline{(Amp-hr_{initial}) - 0.01 * \left(\frac{NHV_{fuel} * m_{fuel}}{V_{system} * K_1} \right)}$$

Where:

$\underline{(Amp-hr_{final})_{max}}$ = Maximum allowed Amp-hr stored in battery at the end of the test

$\underline{(Amp-hr_{final})_{min}}$ = Minimum allowed Amp-hr stored in battery at the end of the test

$\underline{(Amp-hr_{initial})}$ = Battery Amp-hr stored at the beginning of the test

$\underline{NHV_{fuel}}$ = Net heating value of consumable fuel, in Joules/kg

$\underline{m_{fuel}}$ = Total mass of fuel consumed during test, in kg

$\underline{K_1}$ = Conversion factor, 3600 seconds/hour

$\underline{V_{system}}$ = Average charge sustaining battery DC bus voltage (open circuit) during charge sustaining operation. This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board.

10.2 For vehicles that use a capacitor as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$\underline{(V_{final})_{max}} = \underline{\sqrt{V_{initial}^2 + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{C}}}$$

$$\underline{(V_{final})_{min}} = \underline{\sqrt{V_{initial}^2 - 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{C}}}$$

Where:

$\underline{(V_{final})_{max}}$ = The stored capacitor voltage allowed at the end of the test

$\underline{(V_{final})_{min}}$ = The stored capacitor voltage allowed at the end of the test

$\underline{V_{initial}^2}$ = The square of the capacitor voltage stored at the beginning of the test

$\underline{NHV_{fuel}}$ = Net heating value of consumable fuel, in Joules/kg

$\underline{m_{fuel}}$ = Total mass of fuel consumed during test, in kg

\underline{C} = Rated capacitance of the capacitor, in Farads

10.3 For vehicles that use an electro-mechanical flywheel as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$\underline{(rpm_{final})_{max}} = \underline{\sqrt{rpm_{initial}^2 + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{I * K_3}}}$$

$$\underline{(rpm_{final})_{min}} = \sqrt{rpm_{initial}^2 - 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{I * K_3}}$$

Where:

(rpm_{final})_{max} = The maximum flywheel rotational speed allowed at the end of the test

(rpm_{final})_{min} = The minimum flywheel rotational speed allowed at the end of the test

rpm_{initial}² = The squared flywheel rotational speed at the beginning of the test

NHV_{fuel} = Net heating value of consumable fuel, in Joules/kg

m_{fuel} = Total mass of fuel consumed during test, in kg

K₃ = Conversion factor, $\frac{4\pi^2}{3600 \text{ sec}^2 - \text{rpm}^2}$

I = Rated moment of inertia of the flywheel, in kg-m²

11. Calculations – Equivalent All-Electric Range for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

11.1 Charge Depleting CO₂ Produced means the tailpipe CO₂ emissions produced, M_{cd}, in grams during the charge depleting cycle range.

$$\underline{M_{cd}} = \sum Y_i$$

where:

Y_i = the sum of CO₂ mass in the charge depleting mode from each test cycle (UDDS or HFEDS)

i = number (UDDS or HFEDS) of the test over the charge depleting cycle range, R_{cdc}.

11.2 Charge Sustaining CO₂ Produced - urban means the tailpipe CO₂ emissions produced, M_{cs}, in grams during the cold start charge sustaining urban test.

$$\underline{M_{cs}} = Y_c + Y_h * \left[\frac{(R_{cdcu} - D_c)}{D_c} \right]$$

where:

R_{cdcu} = Urban Charge Depleting Cycle Range

D_c = The measured driving distance from the cold start test, in miles.

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$\underline{Y_c}$ = Mass emissions as calculated from the cold start test, in grams per test.

$\underline{Y_h}$ = Mass emissions as calculated from the hot start test, in grams per test.

11.3 Charge Sustaining CO₂ Produced - highway means the tailpipe CO₂ emissions produced, M_{cs} , in grams during the cold start charge sustaining highway test.

$$\underline{M_{cs}} = \left(\frac{R_{cdch}}{D_h} \right) * Y_h$$

where:

$\underline{R_{cdch}}$ = Highway Charge Depleting Cycle Range

$\underline{D_h}$ = The measured driving distance from the hot start test, in miles.

$\underline{Y_h}$ = Mass emissions as calculated from the hot start test, in grams per test.

11.4 Urban Equivalent All-Electric Range (EAER_u) shall be calculated as follows:

$$\underline{EAER_u} = \left(\frac{M_{cs} - M_{cd}}{M_{cs}} \right) * R_{cdcu}$$

where:

$\underline{M_{cs}}$ and $\underline{M_{cd}}$ are the mass of tailpipe CO₂ emissions accumulated over the urban charge depleting cycle range, $\underline{R_{cdcu}}$ (mi).

11.5 Highway Equivalent All-Electric Range shall be calculated as follows:

The Highway Equivalent All-Electric Range (EAER_h) is corrected for cold start given by the following equation:

$$\underline{EAER_h} = \left[\frac{M_{cs} - (M_{cd} - CF_{cd})}{M_{cs}} \right] * R_{cdch}$$

where:

$\underline{M_{cs}}$ and $\underline{M_{cd}}$ are the mass of CO₂ emissions accumulated over the highway charge depleting cycle range, $\underline{R_{cdch}}$ (mi).

$$\underline{M_{cd}} = \sum Y_i$$

$\underline{Y_i}$ = the sum of CO₂ mass in the charge depleting mode from each test cycle (UDDS or HFEDS)

\underline{i} = number HFEDS tests in charge depleting operation

$$\underline{M_{cs}} = \left(\frac{R_{cdc}}{D_h} \right) * Y_h$$

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Y_h , and D_h are the CO_2 mass and distance traveled respectively from the third HFEDS charge sustaining (hot) test.

The Highway Charge Depleting Cold CO_2 Mass Correction,
 $CF_{cd} = (H_{coldcs}CO_2 - H_{warmcs}CO_2)$

where:

$H_{coldcs}CO_2$ and $H_{warmcs}CO_2$ are the CO_2 mass emissions of cold (1st) and warm (2nd) HFEDS charge sustaining tests.

11.6 Electric Range Fraction (%).

The Electric Range Fraction means fraction of the total miles driven electrically (with the engine off) for blended operation hybrid electric vehicles.

The Urban Electric Range Fraction (ERF_u) is calculated as follows:

$$\underline{ERF_u (\%) = \left(\frac{EAER_u}{R_{cdau}} \right) * 100}$$

The Highway Electric Range Fraction (ERF_h) is calculated as follows:

$$\underline{ERF_h (\%) = \left(\frac{EAER_h}{R_{cdah}} \right) * 100}$$

11.7 Equivalent All-Electric Range Energy Consumption.

The Urban Equivalent All-Electric Range Energy Consumption ($EAEREC_u$) shall be calculated as follows:

$$\underline{EAEREC_u (wh/mi) = \frac{E_{cd}}{EAER_u}}$$

where:

E_{cd} = Total DC or AC electrical energy used to fully charge the vehicle battery from an external power source after the charge depleting test has been completed

The Highway Equivalent All-Electric Range Energy Consumption ($EAEREC_h$) shall be calculated as follows:

$$\underline{EAEREC_h (wh/mi) = \frac{E_{cd}}{EAER_h}}$$

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where:

E_{cd} = Total DC or AC electrical energy used to fully charge the vehicle battery from an external power source after the charge depleting test has been completed.

11.8 The Urban Charge Depleting Cycle Range shall be defined as the distance traveled on the Urban Charge Depleting Procedure up to the UDDS cycle prior to where the state of charge is above the lower bound state of charge tolerance for one test cycle given by:

$$\underline{(\text{Amp-hr}_{\text{final}})_{\text{min}}} = \underline{(\text{Amp-hr}_{\text{initial}}) - 0.01 * \left(\frac{NHV_{\text{fuel}} * m_{\text{fuel}}}{V_{\text{system}} * K_1} \right)}$$

Where:

$(\text{Amp-hr}_{\text{final}})_{\text{min}}$ = Minimum allowed Amp-hr stored in battery at the end of the test

$(\text{Amp-hr}_{\text{initial}})$ = Battery Amp-hr stored at the beginning of the test

NHV_{fuel} = Net heating value of consumable fuel, in Joules/kg

m_{fuel} = Total mass of fuel consumed during test, in kg

K_1 = Conversion factor, 3600 seconds/hour

V_{system} = Battery DC bus voltage (open circuit)

11.9 The Charge Depleting Actual Range, R_{cda} , shall be defined as the range at which the state of charge is first equal to the average state of charge of the two consecutive UDDS tests used to end the Urban Charge Depleting Test Procedure. This range must be accurate to the nearest 0.1 miles.

11.10 The Charge Depleting to Charge Sustaining Urban Range shall be defined as the distance driven from the start of test through the UDDS test preceding two consecutive charge balanced UDDS cycles meeting the SOC criteria (section F.10).

11.11 The Highway Charge Depleting Cycle Range shall be defined as the sum of the distance traveled on the Highway Charge Depleting Test up to the HFEDS cycle prior to where the state of charge is above the lower bound state of charge tolerance for one test cycle given by:

$$\underline{(\text{Amp-hr}_{\text{final}})_{\text{min}}} = \underline{(\text{Amp-hr}_{\text{initial}}) - 0.01 * \left(\frac{NHV_{\text{fuel}} * m_{\text{fuel}}}{V_{\text{system}} * K_1} \right)}$$

Where:

$(\text{Amp-hr}_{\text{final}})_{\text{min}}$ = Minimum allowed Amp-hr stored in battery at the end of the test

$(\text{Amp-hr}_{\text{initial}})$ = Battery Amp-hr stored at the beginning of the test

NHV_{fuel} = Net heating value of consumable fuel, in Joules/kg

m_{fuel} = Total mass of fuel consumed during test, in kg

K_1 = Conversion factor, 3600 seconds/hour

V_{system} = Battery DC bus voltage (open circuit)

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11.12 The Highway Charge Depleting Actual Range shall be defined as the range at which the state of charge is first equal to the average state of charge of the last HFEDS test used to end the Highway Charge Depleting Test Procedure.

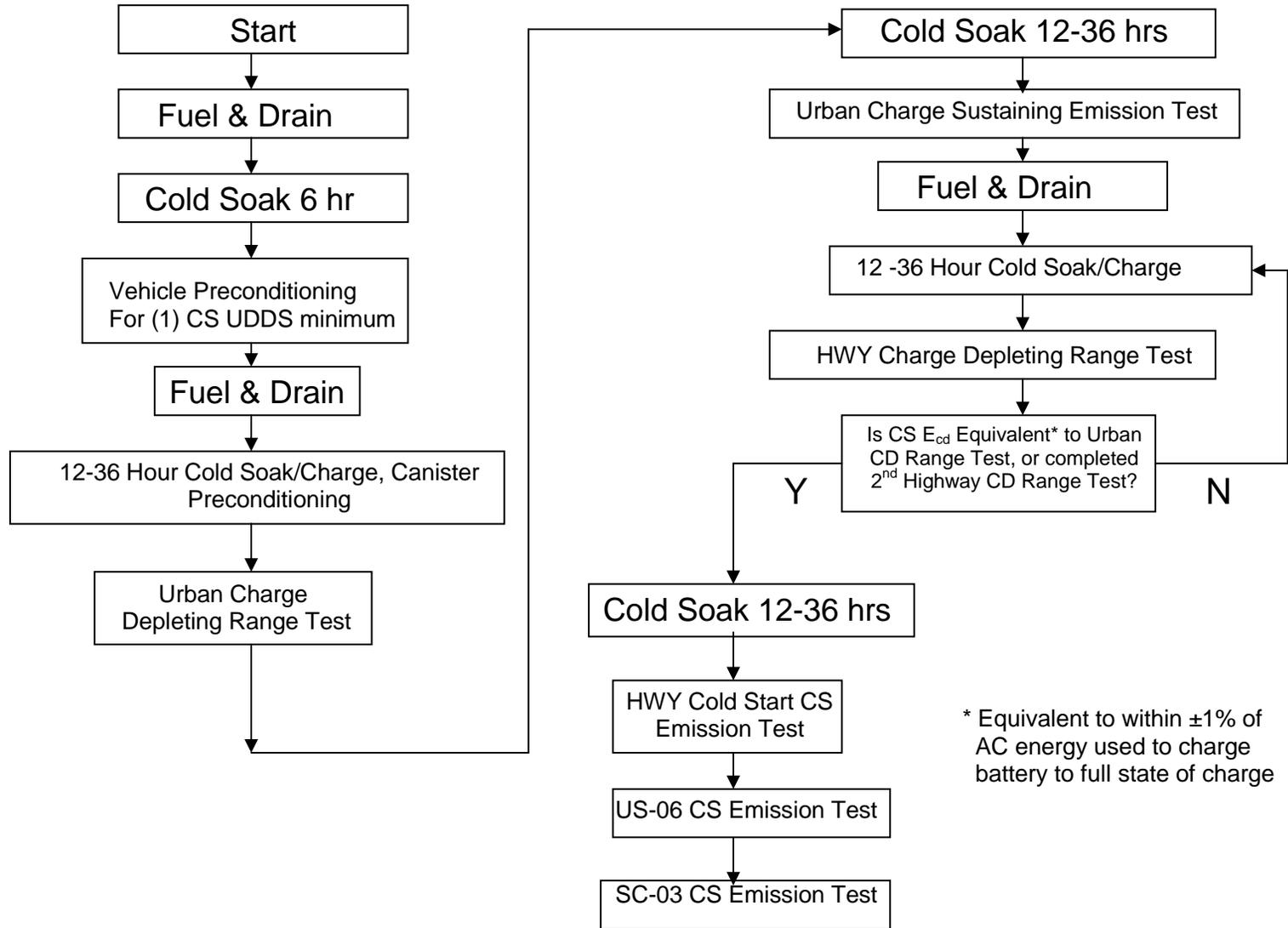
11.13 The Charge Depleting to Charge Sustaining Highway Range shall be defined as the distance driven from the start of the Highway Charge Depleting Test through the HFEDS test preceding the final HFEDS test.

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G. Off-Vehicle Charge Capable Hybrid Electric Vehicle Emission Test Sequence.

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Proposed Off-Vehicle Charge Capable HEV Exhaust Emissions Test Sequence



* Equivalent to within $\pm 1\%$ of AC energy used to charge battery to full state of charge

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H. Examples of Off-Vehicle Charge Capable Hybrid Electric Vehicle Terminology.

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Example of an Off-Vehicle Charge Capable HEV with AER and Blended Operation Undergoing the Urban Charge Depleting Range Test

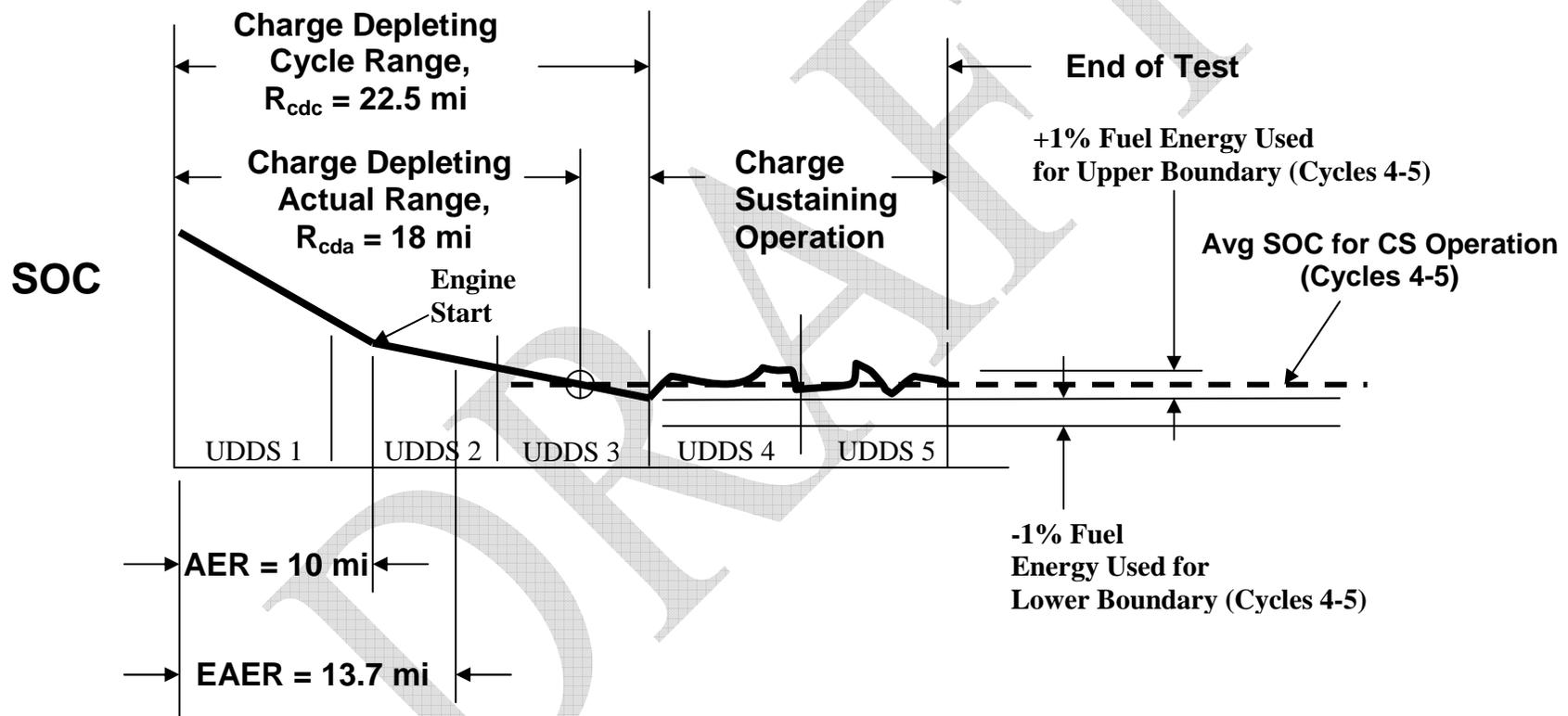
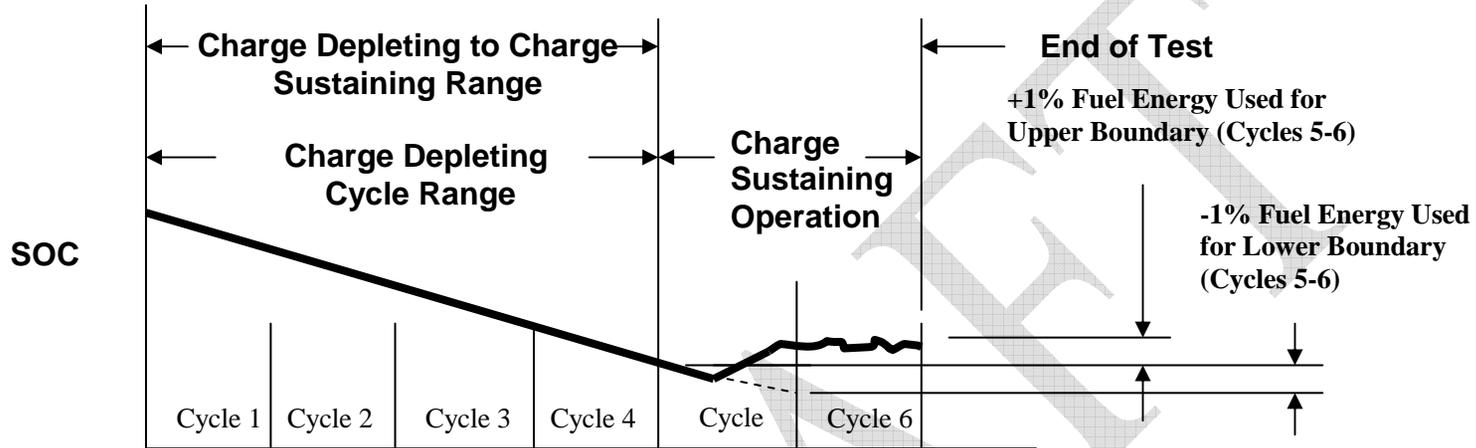
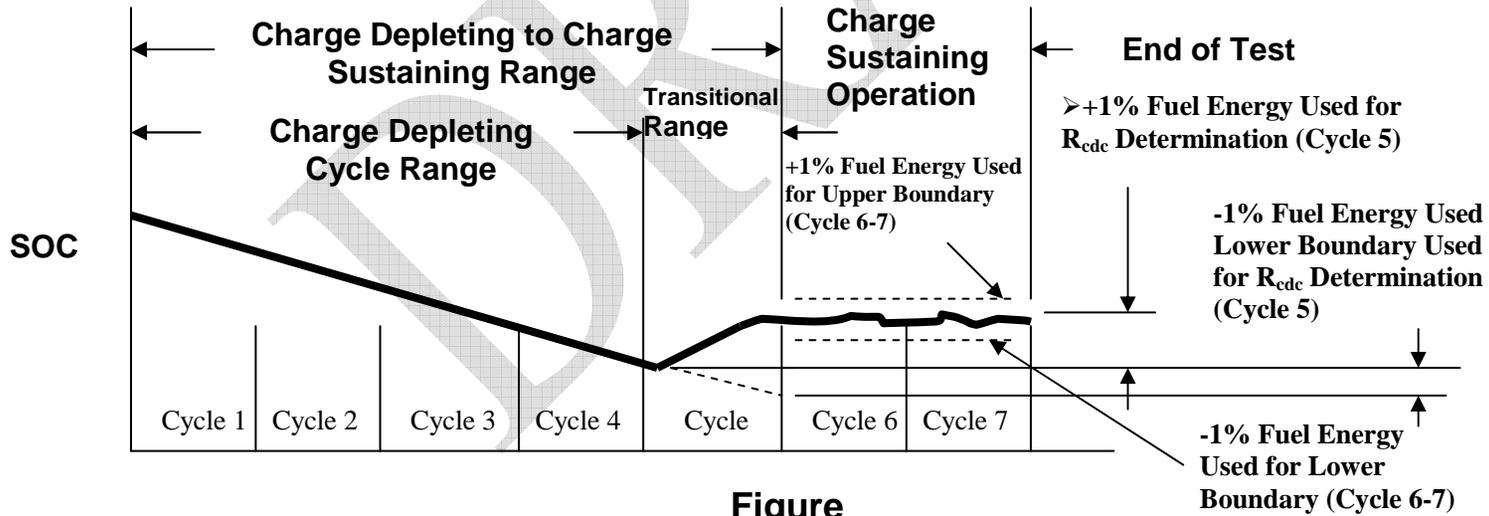


Figure 1

Example of Urban End of Test Conditions for Off-Vehicle Charge Capable HEV



Example of Urban End of Test Conditions for Off-Vehicle Charge Capable HEV with Transitional Range



Figure